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THE SUPERVISING ARCHITECT of the U. S. Treasury Department is to be selected by means of a competitive examination open to all architects, this plan having been decided upon by Mr. Gage, Secretary of the Treasury, and approved by the Civil Service Commission. The position is an important one, involving general supervision of the designing and construction of all new public buildings, although the work of designing buildings, which has heretofore been done exclusively by the supervising architect, will probably be done in the future under the Tarsney law, which permits the secretary of the treasury to secure designs by competition from architects outside the government service. All those who enter the competition will be required to submit written statements relative to their training, education and technical experience. They will also be required to submit drawings or sketch plans, specifications and photographs or other suitable illustrations of buildings designed by them as architects or constructed under their supervision as superintendents of construction. A thesis of not less than 1,000 words relative to designing and construction and a thesis of about the same length relative to office administration will also be required. The first thesis must give in detail the writer's views as to the most appropriate styles of architecture for public buildings and the most economical methods of constructing them, and must also state the advantages or disadvantages of securing the designs for public buildings by competition among American architects and the advantages or disadvantages of having such designs prepared in the office of the supervising architect of the treasury. The second thesis must include a full statement of the experience the writer has had in supervising and directing the architectural office and field work of subordinates or assistants, and his views as to the general administrative policy which should be pursued in successfully carrying on the work of a supervising architect, especially the work of a supervising architect of the treasury department. In addition to the foregoing tests, the competitors will be required to appear on Sept. 10, at points convenient to their places of residence, to undergo a test in formulating a scheme for competition for a public building and in criticising designs submitted to them for their guidance and inspection. The statements and thesis must be forwarded to the Civil Service Commission, at Washington, D. C., by each competitor on or before Sept. 10. The test under the fourth head will be given on Sept. 10. The examination papers will be rated by a board of distinguished architects. The salary of the position is $4,500 per year.

A HEAVY INCREASE IN EXPORTS is reported by the Bureau of Statistics at Washington for July, 1897. Exports for that month amounted in value to $36,945,278; and for the seven months of 1897 to $320,987,075, as compared, for the same period, with $309,811,297 in 1896, and $277,675,335 in 1895. For the month of July the heaviest increase was in corn, or 12,405,466 bushels; an increase of 7,000,000 bushels over July, 1896. For the seven months of 1897 the corn export rose from 84,056,612 bushels in 1896, to 115,600,159 bushels. For the same periods the exports of rye rose from 1,251,158 bushels to 4,893,779 bushels. While there is a decrease in the export of wheat this is more than offset by the increase in price.

TIN PLATE EXPORTS from Great Britain to the United States have decreased at a rapid rate during the last five years, and since the new tariff was put into operation, with its increased duty on tin, this decrease will continue, though undoubtedly at a less rapid rate. Reports issued by the British Government show that during the first seven months of 1893 (Jan. to July incl.) there were shipped to the United States 182,668 long tons of tin plate. During the same period of 1894, 118,169 tons; of 1895, 124,839 tons; of 1896, 73,552 tons, and only 56,564 tons in 1897, up to July inclusive. In other words, the imports of British tin during seven months of 1893 were 3.2 times the imports for a like period of 1897, while at the same time the demand for tin plate in this country had in no way decreased. This leads to the happy conclusion that the home market is being supplied by our own manufacturers, and this conclusion in turn is borne out by reports from all sections. Indeed, the tables are being turned, and, according to report, a recent eastbound steamer carried 500 boxes of American tin plate to England.

IMMIGRATION TO THE UNITED STATES decreased to 230,832 in the last fiscal year. The lightest previous immigration, since 1882, when the government assumed jurisdiction, was 279,948 in 1895. In 1882 the arrivals numbered 788,992; and during the period 1882-1897, 7,432,016 immigrants entered the United States.

A SHIP CANAL is being built by the Kansas City, Pittsburg & Gulf Ry. from its terminal at Port Arthur, Tex. (where it has docks on Sabine Lake), to the deep water of Sabine Pass. The canal will be 8½ miles long, following the west shore of the lake, and will be 175 ft. wide at the water line and 75 ft. wide at the bottom, with 26 ft. of water. The work will involve the excavation of about 500,000 cu. yds. of hard clay. The president, Mr. A. E. Stilwell, informs us that as the canal will not be completed in time for this year's export business, a dock extending 2,700 ft. into Lake Sabine has been built at Port Arthur, from which cars will be carried by lighters to vessels loading at the town of Sabine Pass, which is at the head of the navigation pass and near the mouth of the new ship canal.

THE CHICAGO DRAINAGE CANAL is now to be extended through Joliet, Ill., and the trustees have filed a condemnation suit against 500 owners, tenants, etc., of land required. The stretch of land will be about two miles in length, extending from Jackson St. to the southern limits of the city, the land required being mainly on the east side of the river. Work on the Joliet end of the canal will be commenced shortly, between Joliet and Lockport, and it is said that by November there will be 5,000 men at work.

THE EADS JETTIES are reported by Maj. J. B. Quinn, U. S. Engineers, as having failed for 74 days in the year ending June 30, 1896, to maintain the legal channel depth of 26 ft., owing to shoaling. According to the report an increased dredging plant, or some extension and modification in the dikes and jetties are necessary in the immediate future to maintain the contract depth.

THE MOST SERIOUS RAILWAY ACCIDENT of the week is reported from Germany. In this the Hamburg express was thrown from the track Aug. 14, between Celle and Velzen in the Province of Hanover, and three persons were killed while thirteen were injured.

THE FAILURE OF A LARGE COAL BIN in the Edison Illuminating Co.'s plant, at Paterson, N. J., Aug. 14, will, according to reports, stop the lighting and street car service for several days. Were it not for the fact that the city must suffer as well as the company the accident would be rather amusing, since it occurred as the direct result of the company's efforts to avoid a shut down. Fearing that the miners' strike might result in a shortage the great coal bin which partially surrounded the boilers and extended from the ground to the roof, three stories above, was filled with about 1,000 tons of coal. The unusual strain caused something to give away and the immense quantity of coal poured down through the rent, breaking steam pipes and almost burying the boilers and machinery. Two firemen were caught by the sudden rush and badly bruised but will, it is expected, recover. No further casualties are reported and the damage so far appears to be to the company's property alone.

A 16-IN. GUN CASTING was made at the Bethlehem Iron Works on Aug. 12. It is intended for the tube of a 16-in. gun now being built for the government, and is 19 ft. 6 in. long, octagonal in shape and 74 ins. diameter. More than 100 tons of metal were used in the casting, the first and largest of its kind ever made in this country.

A 10-IN. WIRE-WOUND GUN is being built for the United States at the Scott Iron Works, at Reading, Pa., under the direction of the inventor, Mr. J. H. Brown. This new gun will weigh 30 tons and will be 37½ ft. long. The steel used has a tensile strength of 120,000 lbs. per sq. in. and the square wire measures 1-7 in. on a side and is wound around the core under a stress of 98,000 lbs. per sq. in. The estimated cost is $37,400.

A NEW CAST-STEEL CANNON invented by Dr. R. J. Gatling is being made at Cleveland, O. The gun is to be of 8-in. caliber, and was cast solid by the Otis Steel Co., and is to be drilled out by the Cleveland City Forge & Iron Co. In view of the disappointing results which attended the trial of cast-steel cannon that was made about ten years ago, the results obtained by Dr. Gatling will be awaited with interest.

THE WORLD'S PRODUCTION OF GOLD FOR 1896 is estimated by the Director of the U. S. Mint to have been $205,000,000, of which the United States contributed $53,000,000. The probable gold output for 1897 is estimated at $240,000,000. Australia, in 1896, mined $46,250,000 in gold value; South Africa, $44,000,000; Russia, $22,000,000; Mexico, $7,000,000; British India, $5,800,000 and Canada, $2,600,000. The Director of the Mint believes that with the opening of new mines and with improved appliances and methods of extracting gold, the annual product will exceed $300,000,000 by the close of the century.

AMERICAN TIN PLATE, to the amount of 500 boxes, has been shipped to Italy from the American Tin Plate Co.'s works at Elmwood, Ind. Press accounts say that the same company will ship a like amount to England.

THE NEW NIAGARA BRIDGE recently withstood its official test in a very satisfactory manner. The designs called for a strength sufficient to withstand safely a moving load of 10,000 lbs. per lin. ft., with a deflection of not more than 4½ ins. During the test it was estimated that the bridge was not loaded over 7,000 lbs. per ft. This great weight was made up of trains starting from the Canadian side and moving across to the American, stopping several times to permit the taking of levels. These trains were composed of several 10-wheel consolidation locomotives and coal cars carrying besides their usual rated coal load of 60,000 lbs., rails placed on top to increase the total weight. As the bridge had been in use for several weeks the deflection under full load was quite small, being only ⅞-in. on one side and 1 in. on the other.

THE NEW YORK-BROOKLYN PNEUMATIC MAIL tubes are being laid, after a long delay, by the U. S. Postal Transit Co., of Philadelphia. The plan proposes a line of two 8-in. tubes extending from the Broooklyn post office over the Brooklyn bridge to the New York post office. The capacity of the plant is specified at 123,000 pieces of first-class mail matter each way per hour, making the time between the two offices two to three minutes, instead of 27 minutes, as at present. The cost of this part of the scheme is said to be $125,000 and the U. S. government pays an annual rental of $14,000 for the use of the tubes. The Transit Company pays the Brooklyn bridge trustees a rental of $2,000 per annum for the first two years and $3,000 per year afterwards. The system may be extended to the uptown branch post offices in New York.

THE INTERNATIONAL ASSOCIATION FOR THE testing of materials, according to the last presidential report of Prof. L. von Tetmajer, now has 1,209 members, representing 21 countries. Germany leads with 392 members, and Russia comes next with 228 members. Austria-Hungary has 156; Switzerland, 80; Sweden, 64; the United States 62, and France and Holland have 46 members each. England has only 22 members. The Association now officially publishes its papers and proceedings, generally in both German and French, in the "Baumaterialien Kunde," an international review of experiments with structural materials, edited and published by Prof. H. Giessler, at Stuttgart, Germany. To members of the International Association the subscription price of this journal is 10 marks per annum.

THE WORLD'S RAILWAYS IN 1895, says the Prussian Minister of Public Works, aggregated 433,953 miles in length, as compared with 395,143 in 1891, an increase of 9.8%. To this gain of 38,810 miles, in the years 1891-95, Europe contributed 13,732 miles; Asia, 4,867; Africa, 1,647; America, 16,998, and Australia, 1,566 miles. The total railway mileage for 1895 for these great divisions of the world is put down as follows: Europe, 155,284 miles; Asia, 26,890; Africa, 8,169; America, 229,722; Australia, 13,888 miles. The Prussian Minister, without going into detail, puts the average capital per mile at $120,440 in Europe, and $59,310 for the rest of the world. On this basis the aggregate capital of the world's railways is $35,216,000,000, of which $18,695,000,000, or 53%, is invested in European railways, having 36% of the total mileage.

INLET TOWER OF THE MINNEAPOLIS WATER-WORKS.

The accompanying illustration shows an inlet tower of very meritorious design, in connection with the new water-works reservoir for Minneapolis, Minn. The stone used in the tower is Lake Superior brownstone, and the tiling is a red terra cotta, made by the Celadon Terra Cotta Co., of Alfred Center, N. Y. The structure was designed by Mr. F. W. Cappelen, M. Am. Soc C. E., City Engineer of Minneapolis, who kindly sent us the photograph from which the illustration was made. There are two outlet towers of similar design connected with the reservoir, one of which is shown in the background of the view.

INLET TOWER, MINNEAPOLIS WATER-WORKS.
F. W. Cappelen, M. Am. Soc. C. E., City Engineer.

NEW PASSENGER AND FREIGHT STATION AT MONTGOMERY, ALA.; L. & N. R. R.

(With full-page plate.)

The Louisville & Nashville R. R. is making extensive improvements at Montgomery, Ala., and has already completed a large new freight station, while contracts have been awarded for a handsome new union passenger station. The arrangement and design of the buildings are shown in the accompanying illustrations, and we are indebted to Mr. Robert Montfort, M. Am. Soc. C. E., Chief Engineer of the L. & N. R. R., for blue prints and specifications of the work.

A general plan is given in Fig. 1, from which it will be seen that the new station is near the bank of the Alabama River, between Commerce St. and Moulton St., Commerce St. being connected with the city wharf by means of a subway beneath the tracks. It will be a through passenger station, with tracks passing along in front of the main buildings, while there are also stub tracks at the south end. There are five main passenger tracks and an outer track for through freight service. The connections with the freight yard tracks are at the south end of the station, while at the north end are the diverging tracks of the Louisville & Nashville R. R., the Central R. R. of Georgia, and the Western Ry. of Alabama. A trainshed 600 ft. long, with a slate roof, will cover the passenger tracks in front of the station.

The passenger station comprises three buildings; the main building will be 315 ft. 4 ins. long and 44 ft. 8 ins. wide, and three stories high; about 50 ft. from the north end will be a two-story baggage room, 50 × 60 ft., and about 14 ft. from the south end will be a mail and express building, 30 × 65 ft., having a mail room 15 × 30 ft. The first story of the main building will contain a general waiting room, women's waiting room, colored people's waiting room, dining room, lunch room, kitchen, serving room, ticket office, check office, news-stand and toilet rooms. The first story will have tile floors. The general waiting room will extend through two stories, having a balcony at the level of the second floor. The second and third stories will be used for offices. There will be a porte cochere 35 ft. square in front of the main entrance.

The buildings will have a pitched face ashlar base, Georgia granite, with pressed brick and stone trimmings above the water table. The roofs will be of slate. All the buildings will be heated by steam. The total estimated cost of the improvements is $200,000, and contracts for the three buildings of the passenger station have been awarded to Charles A. Moses, of Chicago, Ill. The contract for the heating apparatus has been let to Jos. McWilliams & Co., of Louisville, Ky.

The street elevation of the passenger station is shown in Fig. 2, while Fig. 3 is a cross section through the general waiting room. The concrete footings for walls and piers will be composed of cement mortar, 1 part Louisville cement and 2 parts sand, mixed with 2-in. broken stone in the proportion of 1 cement mortar to 2 stone. This will be laid and tamped in layers 6 or 8 ins. thick. The stonework is to be of granite, with joints pointed with Meier's "puzzolan" cement mortar having 1 part cement to 2 parts sand. The brickwork will be laid with shore joint, full beds in cement mortar, slushed solid up to the bottom of the window-sill course of the first story; above this the walls will be laid in lime mortar of 3 sand to 1 lime, measured in bulk. In the buff pressed brick face work every other brick in every seventh course is to be of Flemish bond brick, 8½ × 8½ ins., and this face work will be pointed with buff putty mortar. The terra cotta trimmings are to be well burned, semi-glazed and strongly ribbed, and of a buff color to match the bricks. Glen's Falls black marble is to be used for thresholds, and the window sills of the ticket office, check office and news-stand are to be of 1½-in. Tennessee marble, 15 ins. wide. All the rooms on the first floor (except the kitchen) are to have American encaustic tile floors, the tile being laid on a 6-in. layer of concrete on a well-tamped surface, bedded in Alsen's Portland cement mortar on the concrete, and then grouted with the same cement. It is specified that these floors are not to cost more than 45 cts. per sq. ft. (including concrete base), and must be guaranteed for five years.

The timber for framing is to be of long-leaved yellow pine, with seasoned oak for all keys and blocks. The sleepers under the floors of the baggage, express and mail rooms will be of black cypress, bedded in an 8-in. layer of cinders, and covered with 1⅞ × 6-in. matched and rabbetted flooring of yellow pine, secured to each sleeper by two 30-penny nails. Where joists rest on iron or wooden girders and are not built into walls, they must lap each other, be strutted apart at the ends with wood blocks well nailed, and spiked together with four spikes. All joists are to bear directly on brick without shims. The bridging for wooden joists will be 1½ × 3 ins., with one row for spans up to 13 ft., and two rows for greater spans. Steel I-beams are used for floor beams on the first floor, and for lintels, etc. The roofs will be of No. 1 Bangor Excelsior black slate, full 3-16-in. thick, 10×20 ins., laid on a single layer of tarred roofing felt weighing 15 lbs. per square, with 3-in. laps. Valleys, gutters, flashings, etc., will be of tin, having one coat of paint on the under side and two on the upper side. Where incandescent light wiring is to be imbedded in plaster or cement, the insulating conduit system of the Interior Conduit Co., of New York, is to be used.

The roadway and track elevations of the freight building are shown in Fig. 4, while Fig. 5 is a cross section. The concrete is of the same quality specified for the passenger station, made with Louisville tested cement. The walls are of red brick, laid wet, with joints flushed full of mortar, and pointed with red putty mortar. The flooring is of rabbetted stuff, 1⅞ ins. thick, 8 ins. wide, matched, and dressed on one side. This is nailed to each joist with two 30-penny nails. The flooring in the offices is of ⅞-in. grooved planks, 4 ins. wide, securely nailed to each joist. In the clerk's office on the second floor the floor is deadened by laying planks between the joists, resting on strips ⅞ × 2½ ins., nailed to the sides of the joists, which are 2 × 8 ins., 16 ins. c. to c. This leaves a space 5 ins. deep below the floor, which is filled with dry clay.

It will be noticed that the side next to the track is composed entirely of doors, so that a door can always be opened opposite to each car door in a train of cars placed on the track next to the building. The freight doors are of ¾ × 4 ins., tongued, grooved, dressed and beaded stuff, matched. Those on the track side are hung with "Wild West" anti-friction door hangers, made by the Moore Mfg. & Foundry Co., of Milwaukee, Wis. The rollers run on an iron bar furnished by the railway company. The freight doors on the street side are hung with Gardner's 1-in. steel sash ribbon, or Gardner's anti-friction pulleys, with 8-in. wheels, to cast-iron counter weights furnished by the railway company. These doors run easily up and down, in guides, and have spring stops. The four freight doors on the roadway under the clerk's office are Wilson's patent self-coiling steel shutters with iron slides. The building has seven Fairbank's 4-ton platform scales.

On the track side the walls are covered with corrugated iron, No. 26 B. W. G., secured to studs with barbed wire nails. The iron is painted on each side, before being put on, with two coats of purple ironclad paint, containing 90% of oxide of iron. The roof is of No. 1 Bangor black slate, 12 × 20 ins., laid 8½ ins. to the weather, with two copper nails to each slate. All the flashing is of tin, and the ridge and gutters are of galvanized iron. Outside the building, on the roadway side, is a wooden fender with yellow pine rails bolted and spiked to black cypress posts anchored to the wall. The fender is given three coats of white lead paint. There are three anti-freezing fire-hydrants, supplied by 4-in. pipe, and having 2½-in. hose nozzles. Over each hydrant is a Eureka hose reel with 100 ft. of 2½-in. seamless linen hose, with couplings and ⅞-in. nozzle.

In this building are three electric elevators, having a capacity of 5,000 lbs., exclusive of weight of platforms. The size of platform is 8 × 12 ft. The motors are on the second floor, and are run by a 500-volt current supplied by the Mutual Light & Power Co., of Montgomery. These elevators were made and erected by Geiger, Fiske & Co., of Louisville, Ky. The freight station was built by E. F. Dodson & Co., of Atlanta, Ga.

INFLUENCE OF LOAD ON THE POWER OF A WINDMILL.

By E. C. Murphy.*

Although windmills have been in use since the 12th century for performing various kinds of useful work, and though millions are in use at the present time, there is very little definite in-

*Resident Hydrographer U. S. Geological Survey, University of Kansas, Lawrence, Kan.

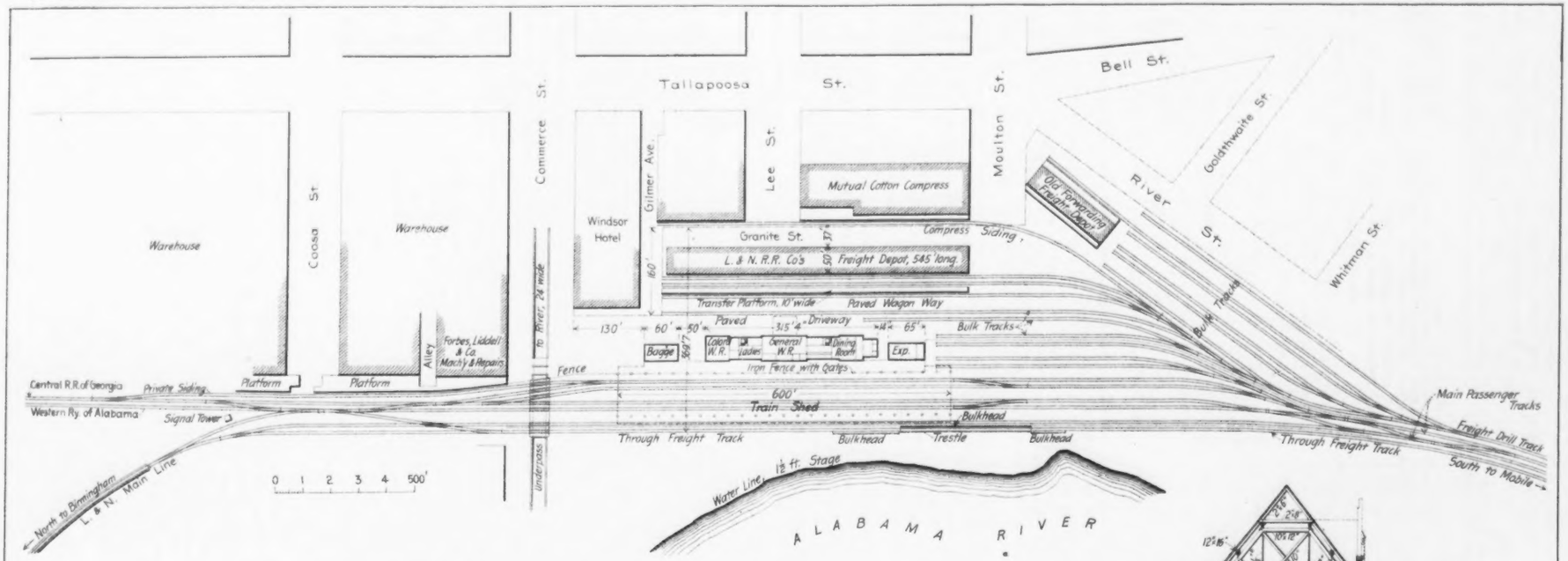


FIG. 1. GENERAL PLAN OF NEW PASSENGER AND FREIGHT STATIONS AND TRACKS.

FIG. 4. ELEVATION OF FREIGHT STATION.

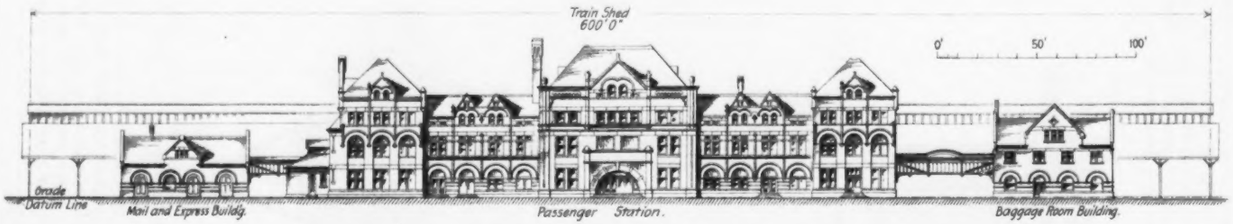


FIG. 2. TRACK ELEVATION OF PASSENGER STATION

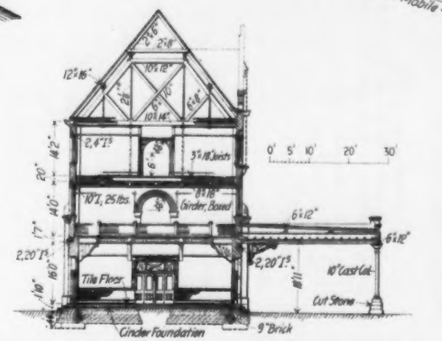


FIG. 3. CROSS SECTION OF PASSENGER STATION.

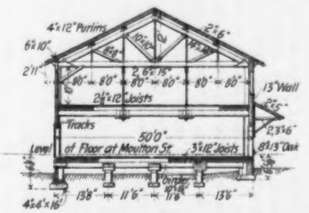


FIG. 5. CROSS SECTION OF FREIGHT STATION.

FREIGHT AND PASSENGER STATIONS AT MONTGOMERY, ALA., LOUISVILLE & NASHVILLE R. R.

R. Montfort, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART & SONS, LITH., 80 VESEY ST., N. Y.

formation in regard to the work they will do in a given wind velocity. There are but few data—if indeed any at all—on the influence of size, shape, angle of fans, method of changing wind area, load on the mill, etc., on the useful work done or the power.

It was to supply in a measure this lack, that during the summer of 1895, the writer made a

Fig. 1.—Working Parts of the Aermotor Windmill.

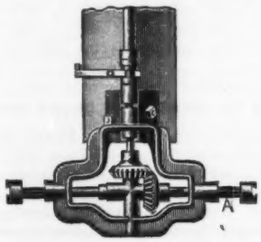


Fig. 2.—Footgear of the Windmill.

number of measurements of the pumping power of windmills, with instruments then at his disposal. During the summer of 1896, with much better facilities, furnished by the U. S. Geological Survey, we have continued the work, extending it to include power as well as pumping mills.

Through the courtesy of Mr. F. H. Newell, Chief of the Hydrographic Branch of the U. S. Geological Survey, I am permitted to use data then collected for this article.

In this paper we wish to show by diagrams how the power of a windmill varies with the load on it. No formula giving the power of a windmill, that the writer has yet seen, recognizes in any way the influence of this factor. That they should do so will be evident from the diagrams.

The influence of this factor can be seen by comparing the useful work done by pumping mills whose load, measured in foot-pounds per stroke of pump, varies, but it can be much better shown by the performance of a "power" windmill. We will therefore use for this purpose the results of tests of the writer's 12-ft. power mill, manufactured by the Aermotor Co., Chicago, Ill. The working parts of the mill are shown in Fig. 1. The wheel, which is on a 30-ft. steel tower, has 18 curved steel fans, each 44 × 18¾ × 7¾ ins., set at an angle of 31° to plane of wheel. Fig. 2 shows the footgear on which is a 9-in. brake pulley.

The shaft is geared forward 6 to 1, so that this pulley makes six revolutions to each revolution of the wind wheel. A friction brake was fitted to this pulley, having an arm of 3 ft., to the end of which was attached a spring balance, reading to ¼-pound. By means of thumb screws the brake would be tightened so as to give any desired reading of spring balance.

The wind velocity was measured with a U. S. Weather Bureau cup anemometer. Each mile of wind was recorded electrically by one pen of a two pen register. The anemometer was held on a pole at the height of the axis of the wheel of windmill and out of reach of its influence. The number of revolutions of brake pulley per mile of wind was found by using a Pratt speed indicator. The time was noted and the speed indicator thrown in gear at the instant that the pen of register indicated the beginning of a mile; the time was again noted and the indicator thrown out of gear when the pen registered the end of the mile. From the time required to make the mile, the velocity of wind was found; from the number of revolutions of the brake pulley, reading of the spring balance and the length of arm of the brake, the number of ft. lbs. of work per mile was found. These results for four readings of spring balance, viz: 0, 2, 4 and 6 lbs. were plotted, using ft. lbs. per mile of wind as ordinates and wind velocity in miles per hour as abscissas, and curves drawn. These are shown in Fig. 3. Many of these measurements were made when the temperature was about 46° F. and barometer pressure 28.9 ins., and these were taken as the standard conditions. Results obtained at other temperatures and pressures were corrected to reduce to standard conditions.

The curve marked 0 load was found with the brake off the pulley and gives the number of ft. lbs. per mile of wind required to overcome the resistance of the moving parts of the mill at different wind velocities. The force required to do this was found by winding a cord around the circumference of the wind wheel and measuring the pull in cord necessary to move the parts at a low speed.

Each curve represents the result of many separate measurements for the whole range of wind velocity shown by each curve.

It is easily seen that the number of ft. lbs. per mile of wind increases with the load on the mill. The dotted curve (A K) is drawn tangent to this curve and is the envelop of them; it would give the relation between the ft. lbs. per mile of wind and the wind velocity if the load on the mill could be gradually increased as the wind velocity increases.

The curves of Fig. 4 show the relation between horse power and wind velocity. They are obtained from those of Fig. 3 by reducing ft. lbs. per mile of wind to horse power. The dotted curve is the envelop of these load curves, and gives the relation between maximum power and wind velocity. It is a parabola.

It is seen that the 2-lb. curve crosses the 4-lb. curve for a wind velocity of 12 miles; for less velocity the 2-lb. load gives more power than the 4-lb. load, and for greater velocities the reverse is true. The 6-lb. curve crosses the 4-lb. curve for a wind velocity of 19 miles per hour, for less velocity the 4-lb. curve gives more power than the 6-lb. and for greater velocity the reverse is true.

The curve A B shows the relation between horse power and wind velocity for total energy of wind at the standard temperature and pressure (48° F. and 28.9 ins.) for a vane area of 73 sq. ft.

The efficiency being the ratio of the useful work done to the energy possessed by the wind is seen to be the ratio of any ordinate of one of these curves to the corresponding ordinate of curve A B. For a given load it is seen to decrease as the velocity increases and for a given velocity to increase as the load increases. The maximum efficiency for a given velocity is the ratio of the ordinate of curve D K to that of A B.

The curves of Fig. 5 show the relation between load and speed of brake pulley for different wind velocities. It is seen that a given change of load reduces the speed much more when the wind velocity is low than when it is high. When the wind velocity is 25 to 30 miles per hour the load can be increased from 2 to 6 lbs. without much reducing the speed. The power is therefore increased nearly threefold, when the wind velocity is 30 miles per hour, by properly increasing the load on the mill.

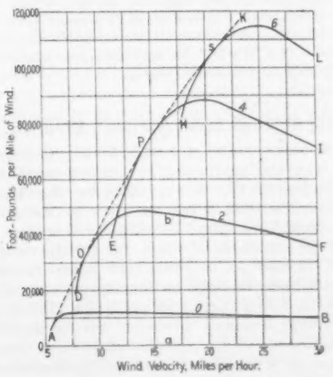


Fig. 3.—Relation of Work Done per Mile of Wind to Wind Velocity, for Different Loads on the Wheel.

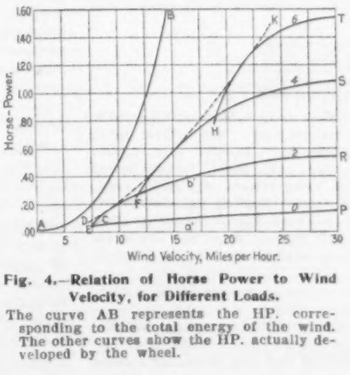


Fig. 4.—Relation of Horse Power to Wind Velocity, for Different Loads.

The curve AB represents the HP. corresponding to the total energy of the wind. The other curves show the HP. actually developed by the wheel.

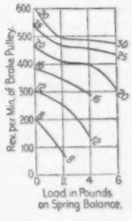


Fig. 5.—Relation of Speed to Load for Different Wind Velocities.

The figures on the curves are velocities of wind in miles per hour.

GARBAGE COLLECTION AND DISPOSAL AT HALIFAX, NOVA SCOTIA.

In May, 1897, Mr. F. W. W. Doane, City Engineer of Halifax, Nova Scotia, awarded a contract, on behalf of the city, to Mr. David Elliott for the collection and removal of garbage, the contract being for one year. At one time the city required the material to be separated by the householders into three classes (as is now the case in New York), but this practice was found to be complicated, involving considerable trouble, and under the present arrangement it is only required to be separated into two classes. In order to facilitate the work of collection the following instructions (with a description of the territory included in each ward) are printed on a card 9¼ × 5½ ins., which is distributed among the householders:

1897.

KEEP THIS CARD.

REMOVAL OF ASHES AND GARBAGE.

Ashes and garbage will be collected on the same night each week, as follows:

Ward One, Monday night, between 8 p. m. and 6 a. m.
Ward Two, Tuesday night, between 8 p. m. and 6 a. m.
Ward Three, Wednesday night, between 8 p. m. and 6 a. m.
Ward Four, Thursday night, between 8 p. m. and 6 a. m.
Wards Five and Six, Friday night, between 8 p. m. and 6 a. m.

Ashes must not be mixed with any other refuse. If garbage, house offal, swill, bones, sweepings, shavings, hair, rags, paper, hay, straw, boxes, shells, tins, cans, bottles, broken glass, crockeryware, vegetable, fruit, rubbish or filth of any kind are found in the same barrel with ashes the contents of the barrel will not be removed by the city carts, but all such barrels have to be removed by the owner, and proceedings will be taken by the Board of Health to enforce the penalty provided by the City Sanitary Code.

In short, ashes must be placed in one barrel; everything else in another.

Barrels must be placed outside of premises not earlier than 7 p. m. and not later than 8 p. m. on the night for removal, and must be taken off the street before 8 a. m. next day.

The city carts will begin to remove ashes and garbage on Monday, May 17, 1897.

From Mr. Doane we have received a copy of the specifications under which the contract for the removal of ashes and garbage was awarded for the season of 1897, and as this is a matter which is of growing importance, especially in large towns and cities, we give herewith some extracts from the specifications, omitting some of the general clauses, and the clauses relative to the failure or neglect of the contractor to properly carry out

the work. Under the provisions of these clauses the engineer may have the necessary work done and deduct the cost from any amount due or that may become due to the contractor. With these exceptions the specifications are substantially as follows:

The word "street" shall be held to include sidewalks, gutters, lanes, roads, squares and alleys; the word "ashes" shall be held to include cinders, coal and everything that usually remains after fires; the word "rubbish" shall be held to include all the loose and decayed material and dirt-like substance that attends use or decay, or which accumulates from building, storing or cleaning; the word "garbage" shall be held to include kitchen and table refuse, swill, rubbish and every accumulation of both animal and vegetable matter, liquid or otherwise, that attends the preparation, decay and dealing in or storage of meats, fish, fowl, birds, or vegetables; and the word "dirt" shall be held to mean natural soil, earth and stone.

The contractor will be required to provide all necessary labor, workmen, horses, carts, plant and material necessary for the removal of all ashes and garbage placed on all streets in the city of Halifax, within the district shown on the plan, in accordance with the provisions of this specification.

Within the said district the contractor shall remove all the ashes and garbage which may be placed by citizens in boxes, barrels or other receptacles upon the streets or sidewalks for the purpose of being removed by the contractor for this work. The contractor shall make good all damage which he or his workmen may do to the said boxes, barrels or other receptacles by handling them roughly or carelessly, and upon the complaint of any citizen the city engineer may, if in his opinion the damage has been caused by the carelessness of the contractor or his men, make such reasonable compensation to the aggrieved person or persons as the engineer may think just and right, and the amount of such damage shall be deducted from any monies which may be due or which may hereafter become due the contractor from the city.

The said boxes, barrels or other receptacles shall be thoroughly and entirely emptied, and the contents removed in such a manner that nothing contained therein shall be dropped or spilled upon the streets, gutters or sidewalks, and they shall be carefully replaced in the same spot in which they were found, or so as to form no obstruction to pedestrians or vehicles.

In case any receptacle in which ashes or garbage has been placed for removal should be found to be overturned, the contractor shall thoroughly and carefully gather and clean up the said ashes or garbage and leave the street as clean as if nothing had been spilled out of the said receptacle, and he shall in like manner gather and clean up all the refuse which may be or may have been spilled or dropped out of any such receptacles, whether they may have been overturned or not.

In case any ashes or garbage shall be found after 7:30 a. m. upon the streets, whether it has been left by carelessness, neglect or design, either in the receptacles where it has been placed for removal or upon the ground, it shall be the duty of the city engineer to cause the same to be carefully gathered up and removed, and the whole cost shall be charged to and retained from the contractor. The contractor, however, shall not be required to remove any piles of rubbish which have not been placed in boxes, barrels or receptacles, nor shall such be gathered up at his expense.

The operations of the contractor shall in all cases be conducted and the work performed between the hours of 8 p. m. and 6. a. m. on the following morning.

Ashes and garbage shall be collected on the same nights each week, as follows:

In Ward One, on Monday night.
In Ward Two, on Tuesday night.
In Ward Three, on Wednesday night.
In Ward Four, on Thursday night.
In Wards Five and Six, on Friday night.

Any barrel, box or other receptacle containing ashes mixed with garbage, rubbish, dirt, house-offal, swill, bones, sweepings, shavings, hair, manure, rags, oyster, clam or lobster shells, tins, cans, paper, bottles, boxes, hay, straw, broken glass, crockeryware, vegetables, fruit, or filth of any kind, shall not be emptied, but shall be left where they are found. All such barrels, boxes or other receptacles which are left on the street for the cause mentioned in this section shall be at once reported to the city engineer.

For each and every violation of the preceding section, of which the city engineer shall be sole judge, the contractor shall be fined the sum of five dollars ($5.00), which amount shall be deducted by the engineer from any money due the contractor, or that may thereafter become due from the city.

Ashes and garbage must not be removed in the same cart. All carts under this contract for carrying ashes, garbage or any other materials shall be strong, tight, free from all leakage, and the sides and ends shall be so high above the load or contents that no part of such contents or load shall fall, leak or spill therefrom; and, if in the opinion of the city engineer it is necessary to prevent the contents of such carts or vehicles from being offensive, each of such carts shall be adequately and tightly covered, as the engineer shall direct.

The contractor must not allow any cart to be so fully loaded or to be in such bad state of repair or of such faulty construction or to be so improperly driven or managed that any ashes or garbage or other material shall fall upon or in any street, place or premises.

The contractor shall not allow any of his workmen or employes to make any unnecessary noise during his operations, and no cart shall stand or remain longer than is absolutely necessary, before or near any building, place of business or other premises, nor shall any cart occupy an unreasonable length of time in loading or unloading or in passing along any street or through any inhabited place or ground.

When not in use all carts and other implements used in the work embraced in this contract shall be kept clean and in an inoffensive condition, and shall be stored and kept in some place where no needless offense shall be given to any person whatever.

All clean ashes collected as hereinbefore specified shall be removed and deposited in such streets, premises or places within a radius of one mile and a quarter from the post office, as the city engineer shall direct. Each load must be dumped or unloaded carefully, as the city engineer shall direct.

Garbage collected as hereinbefore specified shall be removed and deposited in the vicinity of the night-soil pit at Rockhead, or in such place or places as the engineer shall direct. All garbage shall be unloaded as the engineer shall direct.

The foreman of the City Works shall act as inspector and with the engineer shall see that the work is faithfully carried out.

If, in the opinion of the engineer, there should at any time be a number of just complaints against the contractor for neglecting to perform his work in a proper manner, the engineer shall notify the contractor in writing to that effect. If the contractor shall not within five days thereafter take such measures as will, in the judgment of the engineer, insure the satisfactory performance of the work, the engineer shall then notify the contractor to discontinue all work under the contract, and the contractor shall immediately respect such notice and stop his work, and His Worship, the Mayor, shall cancel the contract, and the contractor shall not be entitled to any damages in respect thereof or payments of any money beyond the time affixed by the engineer for the contract to terminate.

The whole work embraced in this specification is to be performed to the entire satisfaction of the city engineer.

The contractor shall give his personal attention to the work and shall not sub-let any part of it without the written permission of the engineer.

Payment will be made fortnightly on the city pay-day at the rate of ninety per cent. (90%) of the amount due on account of the two weeks' work completed on the Saturday previous to such pay-day. The remaining ten per cent. (10%) will be paid within thirty (30) days after the completion of the season's operations. All payments shall be made on the certificate of the city engineer and shall be subject to any deductions for which the contractor may be liable under this contract.

The tender is to include providing all plants, carts, tools, material and labor, and everything else mentioned in this specification or necessary for the proper performance of the work embraced in this contract.

The contractor shall commence work at such time as the engineer shall direct and shall continue his operations until the thirtieth day of October, unless previously notified to discontinue by said engineer, or to continue for a longer period, in which case he shall proceed with the work until the date mentioned in the written notice from the engineer, and he shall be paid for such additional time at the rate named in his tender.

A SELF-FEEDING LOOM WITHOUT BOBBINS.

What appears to be a revolutionary improvement in weaving machinery is now on exhibition at No. 24 Morris St., Jersey City, by the Automatic Loom Co., which has an office in the Mills building, New York city. In ordinary weaving, as practiced for hundreds of years, the shuttle, which is passed to and fro between the warp threads carries a bobbin, or long slender spool, on which is wound the filling thread or weft. In 1733 John Kay, of Bury, England, invented the fly shuttle, so called because of its rapidity of motion, which is produced by a rapid stroke of the "picker stick" at either side of the loom. Previous to that date the shuttle was thrown by hand. The machine now in operation in Jersey City is an ordinary loom in all respects, except that a new beam is substituted for the old one, and a more slender shuttle is used which is without a bobbin. At each end of the beam there is a device for delivering the thread to the shuttle. The shuttle is a rectangular metal or wooden bar, about ten inches long, provided at each end with a pair of pincers which are closed by a spring so as to tightly grasp the end of the thread. On the floor at each side of the loom stands a large spool on which may be carried a mile or more of the filling thread. The end of the thread is carried upward from the spool to a gripping device on the end of the beam. The pincers on the end of the shuttle grasp the end of the thread as it stands in the grip at the end of the beam, on, say, the right hand, and as the picker stick strikes the shuttle and carries it to the other or left hand end of the beam it pulls the thread with it. The thread is then cut off at about ¼-in. from the right hand edge of the fabric. The shuttle thus being thrown to the left the pincers on the left end grasp the end of the thread coming from the left hand spool and at the next throw of the picker stick carry it toward the right end of the beam again. On each throw of the shuttle the end of the thread which had on the previous throw been left sticking out beyond the last thread of the warp is bent over so as to pass between the warp threads and thus form the selvage.

The new form of shuttle being more slender than the other, the alternate threads of the warp do not have to be separated so far as in the ordinary loom; or, in weaver's terms, so large a "sied" does not need to be made to allow the shuttle to pass through.

The great advantage of the new form of loom is that it runs continuously, without the necessity of stopping to take out the empty and insert the full bobbins. The saving of time is claimed to be 30%. The loom may be run at from 150 to 200 picks per minute, laying in from 2½ to 3½ threads per second.

The loom as above described has only two spools of filling thread, but for color work an attachment called a "color feeder" is used. This enables the loom to weave with seven different colors of filling thread, laying in as many different threads of each color as desired. When the attachment is set the filling stripes may be made wide or narrow automatically without stopping the loom.

STRENGTH OF CONNECTICUT BROWN FREESTONE.

We have received from Mr. Frank E. Knight, 516 Syndicate Building, New York city, tables of results of a series of tests of Connecticut brown stone, made on the Emery testing machine, by Prof. Ira E. Woolson, of the Engineering Department of School Mines of Columbia University, to determine its resistance to compressive and to transverse stress. The stone was from three quarries, viz., those of Brainerd, Shaler & Hall, and the Middlesex Quarry Co., Portland, Conn., and the New England Brown Stone Co., Cromwell, Conn. The results obtained are much higher than those published in engineers' and architects' handbooks, which were probably obtained from specimens improperly prepared and bedded, with the old hydraulic jack and lever recording gages of a past period. The following is a summary of the results of the tests:

Summary of Tests upon Connecticut Brownstone, by Prof. Ira H. Woolson, E. M.

Tests for Compressive Resistance of 3-in. Cubes.

Stone from	Maximum load, lbs.	Compressive resistance per sq.in., lbs.
Brainerd, Shaler & Hall Quarry Co.:		
Specimen No. 1.	110,400	12,221
" " 2.	98,200	10,871
" " 3.	112,400	12,385
" " 4.	102,400	11,306
From the Middlesex Quarry Co.:		
Specimen No. 1.	105,700	11,605
" " 2.	94,000	10,466
" " 3.	87,500	9,629
" " 4.	112,400	12,498
From the New England Brownstone Co.:		
Specimen No. 1.	117,100	12,947
" " 2.	110,000	12,041
" " 3.	117,100	12,947
" " 4.	98,000	10,594
Average resistance (12 specimens)		11,625

Transverse Tests, Sections 4 × 6 × 20 ins.

From	Distance bet. supports.	Ultimate strength, lbs.	Modulus of rupture R. lbs.
Brainerd, Shaler & Hall Quarry Co.: No. 1.	19 ins.	9,500	1,864
No. 2.	19 "	9,300	1,857
" 3.	19 "	10,500	2,073
" 4.	19 "	9,800	1,933

Middlesex Quarry Co.:			
No. 1. 19	"	11,500	2,282
" 2. 19	"	9,400	1,880
" 3. 19	"	10,200	2,025
" 4. 19	"	10,900	2,168
New England Brownstone Co.:			
No. 1. 19	"	9,900	1,961
" 2. 19	"	10,400	1,977

Ave. modulus of rupture R (10 specimens), lbs...2,000

THE EXPLOSIVE PROPERTIES OF ACETYLENE.

In a paper read before the Chemical Section of the Engineers' Society of Western Pennsylvania on May 20, Professor F. C. Phillips presented a review of the many explosions of compressed acetylene gas that are on record, and discussed their probable causes. We quote some extracts from his paper below:

The success attained in the early experiments with acteylene as an illuminant led to a demand for the gas in compressed or liquified form convenient for transportation and use. It was found, however, that when inquiries were made of those who were interested in the development of the industry, the reply was always to the effect that while calcium carbide was regularly on sale, acetylene could not be bought. It seems probable that the failure to supply the gas may have been due to some extent at least to a knowledge that it is liable, under certain conditions, to undergo explosive decomposition, and that serious dangers might attend its compression or liquefaction in iron cylinders after the method so long in use in the case of nitrous oxide, carbon dioxide and other gases. The occurrence of several violent explosions of liquefied acetylene has drawn attention anew to the possibility of accidents from its use, and its more general introduction for illuminating purposes is likely to be delayed until the real cause of such explosions is clearly understood, and their avoidance rendered possible.

After discussing at length the history of several accidental explosions of acetylene, the results of experiments made with a view of testing its explosive properties, and the theories advanced by different writers to account for the explosions, Prof. Phillips concludes his paper as follows:

In spite of some disagreements on the part of the authorities cited a summary of their views might be given as to the chief causes of danger from acetylene.

(1) The production of acetylene by the action of water upon calcium carbide is not wholly without danger where large quantities of carbide are used. Its production under pressure is liable to cause local superheating and possibly explosion.

(2) Gaseous acetylene under atmospheric pressure cannot under ordinary conditions be made to explode.

(3) As the pressure increases beyond two atmospheres, the danger from explosion from all causes is enhanced.

Acetylene, under six atmospheres pressure, is likely to explode if heated to 780° C.

(4) Neither gaseous nor liquid acetylene can be exploded by shock unless from the effects of the shock the containing vessel is broken, and then the heat resulting from an impact, or possibly a spark, may cause an explosion of the contents en masse. (The shock of the acetylene explosion in Pictet's factory did not induce explosion of other charged vessels standing near.) As regards the results, however, it would make very little difference whether the cause is to be looked for in the shock, or in the heat produced as an effect of the shock, and it may be safely stated, therefore, that violent shocks of any kind might give rise to explosion.

(5) Concerning the possibility of the production of the acetylene copper compound a difference of opinion exists. It seems probable that the views of Julius Pintsch are correct, and that the copper acetylene only results when copper is exposed to imperfect oxidation in presence of acetylene. In presence of dry acetylene, free from air, no such compound is likely to form.

(6) Acetylene should be purified from phosphorus and sulphur compounds as far as possible before it is subjected to compression.

In view of the somewhat uncertain nature of the information concerning the causes of acetylene explosions, it is not surprising that the authorities and the insurance companies have been at sea in attempting to provide against risks of accident. According to an order issued in December, 1896, by the police officials of Berlin, the production, liquefaction and storage of acetylene are to be subject to the same restrictions as are in force in the case of high explosives. (Jour. f. Gasbel. and Wasserv., 1897, p. 29.) The rule has been adopted upon the German railroads that the steel vessels used to contain liquid acetylene for shipment shall be charged only to the extent of one-third of their capacity. In this way it is expected that the pressure developed in the case of an explosion will be lessened.. (Journal f. Gasbel. and Wasserv., 1897, p. 152.) The police officials of Paris have adopted strict regulations governing the manufacture and handling of acetylene.

In the United States the Underwriters' Association of the Middle District, have issued a circular, dated April 20, 1897, agreeing to permit the use of acetylene by policyholders, provided that vessels containing liquid acetylene and all pressure regulators be kept out of the house. The same rule applies to acetylene generators and calcium carbide. The pressure of the gas in the pipes in houses must in no case exceed four ounces.

The wonderful light-giving power of acetylene, amounting to twelve times that of good coal gas, together with its freedom from poisonous properties, when pure, render it very desirable that means may be found for averting the dangers which have so far tended to impede its more general introduction as an illuminant.

A MANNESMANN-TUBE BRIDGE.

There has been lately constructed in Austria, over the Radotin River, an interesting bridge, here illustrated and used in connection with a horse tramway leading to the stone quarries of Herr Max Herget, of Prague. This bridge, which has a span of 70½ ft., was designed by Prof. Steiner, at the works of the Mannesmann Construction Co., of Prague, and it was erected by the Prague Engineering Co., late Rushton & Co.

BRIDGE OF MANNESMANN TUBES, NEAR PRAGUE, AUSTRIA.

The bridge was designed for a gage of 2 ft. 3½ ins., and a gross "truck weight" of 3½ tons. With the exception of the lateral connections the bridge is made of round Mannesmann tubes, of the following dimensions: The top and bottom chord tubes are 4.48 ins. diameter and from 0.197 to 0.276-in. thick; the verticals are 2.70 ins. diameter and .197-in. thick, and the diagonal tubes decrease from 2.70 ins. diameter. As nearly as can be learned from the drawings which we have received the ends of the posts and ties are flattened and riveted to fish plates, connected with a section of tubing passing over and riveted to the top and bottom chords. A 1½-in. pin passes through the post-tube and the chord pieces and joins to the bottom lateral tubes, as shown.

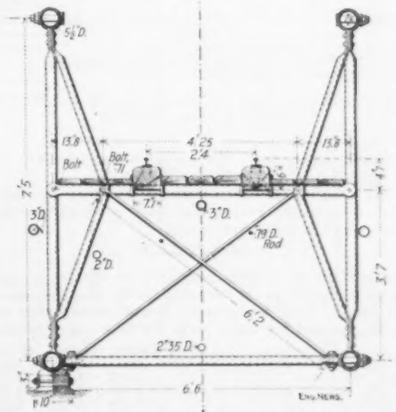
The cross-girder, or floor-beam, supporting the track is also a tube, 3 ins. diameter, and this tube carries the longitudinal wooden track stringers, with plank laid between and outside the latter. The trusses are braced by inside bent tubes, flattened and curved at the angle point so as to fit against the cross-girder, to which it is connected by pins also carrying the upper ends of the stay-rods. The general construction is further shown in the accompanying illustrations.

When completed this bridge was tested by passing over it two 3½-ton trucks, as shown in the photograph reproduced. The authority from which we obtain the above details does not explain why Mannesmann tubes were used at all, nor is the comparative economy of the construction discussed.

INLAND NAVIGATION IN THE UNITED STATES.

A paper upon "Inland Navigation in the United States" was lately presented to the Institution of Civil Engineers by Major Smith S. Leach, Engineer Corps, U. S. A. As published in the excerpt minutes of Proceedings of the Institution, we learn that this paper has been much condensed and greatly changed in form of expression; but we take from it the following extract which briefly summarizes the extent of inland navigation in the United States:

The length of the navigable rivers of the United States on which some measure of improvement has been undertaken exceeds 26,400 miles. The geographical distribution is: Atlantic slope, 5,300 miles; Gulf slope, 4,280 miles; Mississippi basin, 15,100 miles; Lake basin, 300 miles; and Pacific slope, 1,500 miles. The Great Lakes have in the United States a developed shore-line of 4,700 miles, along which are seventy-six harbors, improved or artificially created; while the bays and sounds of the Atlantic coast have 3,600 miles, and those of the Pacific, not including Alaska, 1,900 miles, making a total of 10,200 miles of shore along which goods might be embarked for water transportation. Of the 26,400 miles of navigable rivers, 19,500 miles have been improved for open navigation, distributed as follows: of 3 ft. depth or less, 7,941 miles; of 4 ft. depth, 3,373 miles; of 5 ft. depth, 3,200



Cross Section of Mannesmann Tube Bridge.

miles; of 6 and 7 ft. depth, 2,799 miles; of 8 to 10 ft. depth, 1,550 miles; of 11 to 20 ft., 280 miles, and of more than 20 ft. depth, 246 miles.

Besides this open navigation, projects have been approved and work completed or begun for 2,400 miles of slack-water navigation, with locks and fixed or movable dams. These projects will require 193 locks, with a total

lift of 1,850 ft. Ninety-two locks have been constructed and are now in operation, with a total lift of 820 ft., which give 1,085 miles of navigation of 4 to 7 ft. depth.

There are 32 miles of lateral canals in operation to avoid rapids on the St. Mary's, Mississippi, Ohio and Tennessee rivers; and on the latter stream 11 miles more are under construction. There are also 31 miles of "cut-off" canals in operation, providing shorter and safer routes; and another canal of this class, 50 miles long, from the Mississippi to the Illinois, is under construction. All these are owned by the United States, and are free. In addition, 4,665 miles of canals have been built by States and corporations, comprising both of the classes named, and a third class which may be called connecting canals, uniting two separate drainage-basins having no natural inland water communication. Of these, 2,215 miles have been abandoned, leaving 2,450 miles in operation, with 987 locks aggregating 9,722 ft. lift. The canals in operation average a lock to 2.6 miles. Of those abandoned, 483 miles had 502 locks, and a ratio of a lock to the mile would probably be a fair average for all of them.

The Erie Canal has been almost constantly in course of enlargement, first by doubling its locks and then by lengthening them, which latter work is now complete except at the flights. Under a new project of enlargement just adopted the Erie Canal will be deepened to 9 ft., and the Champlain Canal to 7 ft. Probably hydraulic lifts will replace the flights at Lockport and Cohoes, and possibly elsewhere. Other important projects in progress are the Hennepin Canal, connecting the Mississippi at Rock Island with the Illinois near Lasalle, and the Chicago Drainage Canal, which will ultimately replace the Illinois and Michigan Canal. Surveys are being made by the United States to determine the feasibility of a modern canal across Ohio. Surveys have also been made for a ship canal from Pittsburg to Lake Erie.

The total expenditure on works of inland navigation has exceeded $450,000,000, one-ninth of which is represented by the abandoned canals.

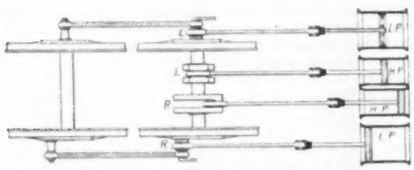


Fig. 2.—Diagram Plan of Balanced Locomotive, Showing Relative Position of Pistons.

THE COST OF STEAM ROLLING OF ROADS is taken up by L. Pierret, in the "Anhales des Ponts et Chausseen" for August, 1896. He takes 12, 16 and 19-ton rollers and divides the cost per ton of roller per mile run as follows:

	12-ton, cts.	16-ton, cts.	19-ton, cts.
Coal, etc.	1.348	1.348	1.378
Wages	2.298	1.716	1.410
Repairs	1.134	1.134	1.104
Interest and sinking fund	.706	.582	.460
Totals	5.486	4.780	4.352

Mr. Pierret considers the first of these figures as approximately equivalent to the cost of rolling by contract when the expense of moving the roller from place to place must be considered. This item is saved when the road authorities own the roller, as these figures would include idle days. The heaviest roller shows the greatest economy. In the above the cost of road material, labor in its distribution, supervision, watering, etc., are not included; but the first item includes coal, water, waste, etc.

THE STRONG COMPOUND BALANCED LOCOMOTIVE.

Investigations into the question of the counterbalancing of locomotives which were made a few years ago showed that in very many cases the counterbalance weights were so excessive, or so badly placed, as to cause a very serious hammer-blow effect upon the rails, although these weights are intended to prevent this effect and to make the engines ride easily and steadily. This question has been so fully presented and discussed in our columns that it need not be further considered here, except to remark that there are two sets of weights to be counterbalanced, the reciprocating and the revolving, and it is the former which generate the forces which, if not properly provided for, cause such damaging effects to the rails and track. Two ways suggest themselves for the improvement of the locomotive in this particular: First, to calculate the weights carefully, and to see that the counterbalances are properly situated on the wheel; second, to devise a "balanced" engine in which no weights in the wheels will be required to balance the reciprocating weights. In the present article we describe such a "balanced" locomotive.

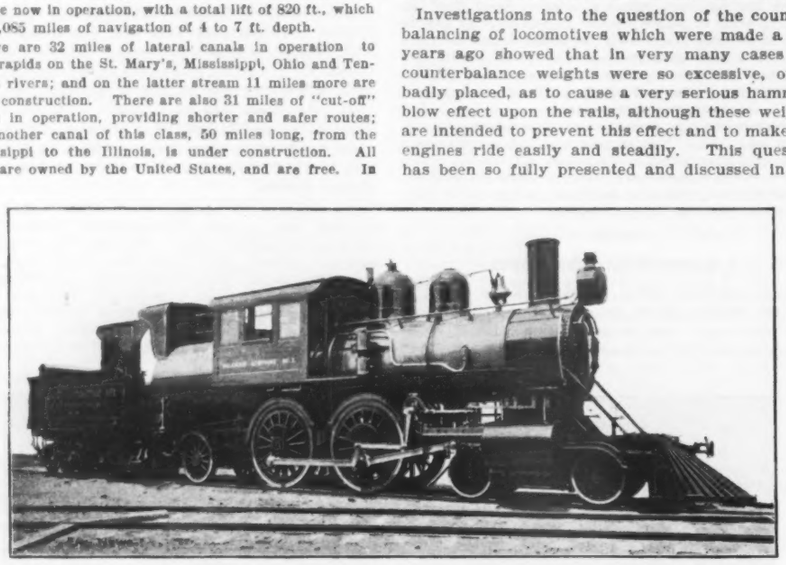


FIG. 1.—FOUR-CYLINDER COMPOUND BALANCED LOCOMOTIVE.
Balanced Locomotive Engineering Co.; Geo. S. Strong, Designer.

This engine was designed by Mr. George S. Strong of New York city, and its general appearance is shown in Fig. 1. It is not an entirely new engine, but is one of Mr. Strong's double-firebox engines (with corrugated flue furnaces), the "A. G. Darwin," rebuilt and converted from an ordinary simple engine into a compound and balanced engine. This engine was described in our issue of April 6, 1889, in connection with its two exhibition runs of 423 miles (New York to Buffalo and return) on the Erie R. R. It may be appropriate to state here that one of the great claims of the duplex firebox was that it would enable the engine to make exceptionally long runs, since one fire could be thoroughly cleaned while the other was burning brightly and keeping up steam. This double furnace, with corrugated fireboxes and combustion chamber, has been used on the Lehigh Valley R. R. for a number of years, one engine having now been in service 14 years, during which time no repairs have been made to the firebox, and the fireboxes are apparently in as good condition as they were when put in. The grate area is about 50 sq. ft., and by alternate firing the gases are consumed and smoke is not produced in using soft coal.

This engine originally had two cylinders, 19 × 24 ins., with three vertical gridiron valves to each cylinder. The boiler, firebox and wheels are retained, and the same types of valves are used, but the engine has now two inside high-pressure cylinders and two outside low-pressure cylinders, all connected to the front driving axle, and operating as two independent two-cylinder compound engines. It is compounded in such a way that the reciprocating parts on the high-pressure cylinders balance the reciprocating parts on the low-pressure cylinders.

To each engine there are six vertical gridiron valves, twelve in all, there being two admission valves and one exhaust valve to each cylinder. Each valve has nine rectangular ports, and the travel is very short, so that there is a very quick opening and closing of a large port area with little motion of the valve. These valves, as already noted, have been used on other locomotives constructed after designs by Mr. Strong, and they have been in use for some 16 years on the Lehigh Valley R. R. By their use the clearances are very much reduced and the port opening is very much increased, so that the engine is much quicker and more powerful than an engine having the ordinary slide valves. In practice it is quite smart, and does not have the loggy disposition manifested by some other compound locomotives.

The valve-gear is a modification of the well-known Walschaert valve gear, used quite extensively in France and Belgium; and it is so arranged as to make the cut-off on the high-pressure cylinders entirely independent of the cut off on the low-pressure cylinders, while the exhaust of the high-pressure cylinder is also independent of that of the low-pressure cylinder. The valve gear has also the peculiarity that it allows the valve to come nearly to a rest at the period when the port is covered, and to move rapidly at the period of opening, when the valve is balanced, either by compression or by expansion of the steam. The full travel of the valve is only 1 1-16 ins., and the travel of the steam valve, at the earliest cut-off, is only 7-16-in.

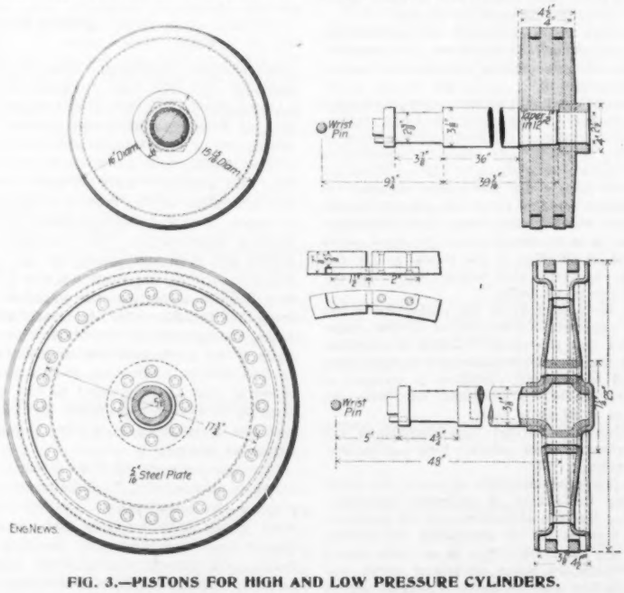


FIG. 3.—PISTONS FOR HIGH AND LOW PRESSURE CYLINDERS.

By reference to the perspective view, Fig. 1, it will be seen that the locomotive is of what is now commonly termed the "Atlantic" type, having four coupled driving wheels, a four-wheel leading truck and a two-wheel trailing truck.

In order to provide for balancing the reciprocating parts, the high-pressure pistons and appurtenances are of equal weight with those of the low-pressure pistons. The high-pressure pistons are of cast iron, 4½ ins. thick, with two cast iron packing rings, ⅞ × ⅜-in. The piston rods are 3⅛ ins. diameter, let into the pistons with a taper

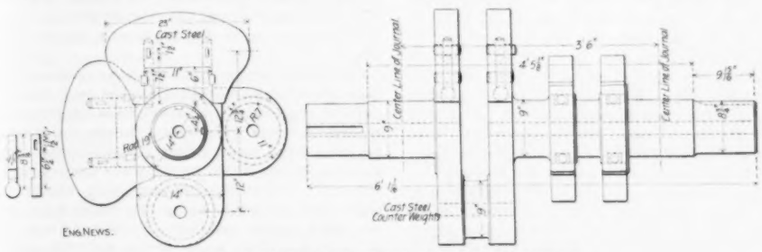


FIG. 4.—CRANK AXLE OF BALANCED LOCOMOTIVE.

fit and secured by nuts. Each low-pressure piston is built up of two dished steel plates, 5-16-in. thick, riveted together over a circumferential ring and a central hub. The piston rod is hollow, 3⅛ ins. diameter, with a 2-in. hole, and its end is forged out to form the hub for the piston. The packing is the same as on the high-pressure pistons. The details of construction are shown in Fig. 3. The crossheads are of the type invented by Mr. F. W. Dean, with a single overhead slide-bar, and these crossheads are made hollow, as shown in Fig. 5, in order to keep down the weight of the reciprocating parts.

The revolving weights are counterbalanced in the usual way, by means of cast iron weights secured to the wheels. The shape, as may be seen by Fig. 1, differs from the ordinary shape, there being part of the weight near the tire and part near the center of the wheel.

One of the interesting features of this engine is, of course, the crank axle, for, with the possible exception of some old inside-cylinder engines which may still be in service, this is probably the only American locomotive having a double-cranked axle. The Erie & Wyoming Valley R. R. has some three-cylinder simple engines with driving axles having a single crank, as illustrated in our issue of Feb. 7, 1895. The axle is of steel, and is shown in Fig. 7. It is 6 ft. 1 1-16 ins. long, 3 ft. 6 ins. c. to c. of jounrals, and has 9-in. crank-pins and journals, while the wheel seats are 8¾ ins. diameter. The crank arms are 4 ins. thick, and 4½ ins. apart. The counterweights are of cast steel, and are attached to the crank arms by keyed pins.

The engine is designed for heavy express passenger service, and will burn either soft or hard coal. The alteration or rebuilding was done at the works of the Maryland Steel Co., Sparrow's Point, Md., under the supervision of Mr. Strong. The engine has been operated for a short time on the railway between Sparrow's Point and Baltimore, and has undergone a thorough series of tests on the locomotive testing apparatus at Purdue University, Lafayette, Ind. In these tests soft copper wires passed between the driving wheels and the driving disks of the apparatus have shown but little of the irregular deformation produced by engines which are out of balance, and it is said that these tests have shown the engine to be in very good balance.

This engine is owned by the Balanced Locomotive & Engineering Co., 1 Broadway, New York city: President, Henry Warden; Vice-President, George S. Morison, M. Am. Soc. C. E.; Secretary and Treasurer, James MacNaughton.

The general dimensions of the engine are given below in our standard form:

Dimensions of Strong's Balanced Locomotive.

Running Gear:	
Driving wheels, diameter	5 ft. 8 ins.
Truck wheels, diameter	2 " 9 "
Trailing wheels, diameter	3 " 6 "
Tender wheels, diameter	2 " 9 "
Engine truck	Swing center.
Journals, driving axles	8 x 11 and 9 x 11 ins.
" truck axles	6 x 11 "
" trailing axles	7 x 11 "
" tender axles	4½ x 8 "
Wheel Base:	
Driving	7 ft. 6 "
Truck	7 " 0 "
Total engine	29 " 6 "
" tender	16 " 3 "
" engine and tender	52 " 7 "
Truck pin to center of leading driver	10 " 6 "
Weight in Working Order:	
On driving wheels	87,600 lbs.
On truck wheels	32,900 "
On trailing wheels	22,800 "
Engine, total	143,300 "
Tender total	80,000 "
Engine and tender, loaded	223,300 "
Tender, empty	25,700 "
Of full coal capacity	14,000 "
Of full water capacity of tank	28,300 "
Allowed for water in boiler	20,000 "
Cylinders—h. p. (2)	16 x 24 ins.
" l. p. (2)	23 x 24 "
Ratio of area of h. p. to l. p.	2 to 1
Distance center to center	6 ft. 7 ins.
Piston rod, diameter	3⅛ "
Form crosshead and guides (aluminum bronze crossheads)	Dean patent.
Connecting rod, length between centers	7 ft.
Valve Gear:	
Type	Walschaert.
Slide valves (12)	Vertical, gridiron.
" lap	5-16-in.
" lead (constant)	1/32-in.
" maximum travel	1-in.
Ports (9 to each valve)	¾ x 4⅜ ins.
Boiler:	
Type	Straight top.
Diameter of barrel inside	4 ft. 10 ins.
Thickness of barrel plates (welded seams)	7-16-in.
Thickness of smokebox tube plate	9-16-in.
Height from rail to center line	8 ft. 0 ins.
Length of smokebox	3 " 11 "
Working steam pressure	170 lbs.
Firebox:	
Type	Strong's corrugated flue.
Length inside, each flue	7 ft. 6¼ ins.
Smallest diameter, inside each flue	3 " 2¼ "
Combustion chamber, length	8 " 10 "
Combustion chamber, diameter	3 " 2¼ "
Thickness of plates	7-16-in.
Thickness of tube sheets	9-16-in.
Grate area	50 sq. ft.
Water space, width	3 to 13 ins.
Tubes:	
Material	Wrought iron.
Number (205, 2-in.; 10, 3-in.)	215
Diameter inside	2 ins.
Diameter, outside	2¼"
Length between tube plates	10 ft. 6 ins.
Total fire area of tube openings	5 sq. ft.
Heating Surface:	
Ratio to grate area	1 to 33
Total, with exterior tube area	1,650 sq. ft.
Miscellaneous:	
Exhaust nozzles (2), diameter	4½ ins.
Smokestack, smallest diameter (lining)	1 ft. 5 "
Smokestack, height from rail to top	14 " 4½"
Capacity of tank	3,400 gallons.
Capacity of coal space	14,000 lbs.
Brake fittings	Westinghouse.
Tractive force per lb. effective pressure on piston (23-in. piston)	186 lbs.
Total tractive force with effective pressure = 150 lbs.	27,900 lbs
Total adhesive tractive power, at ¼ of weight on drivers	21,900 "

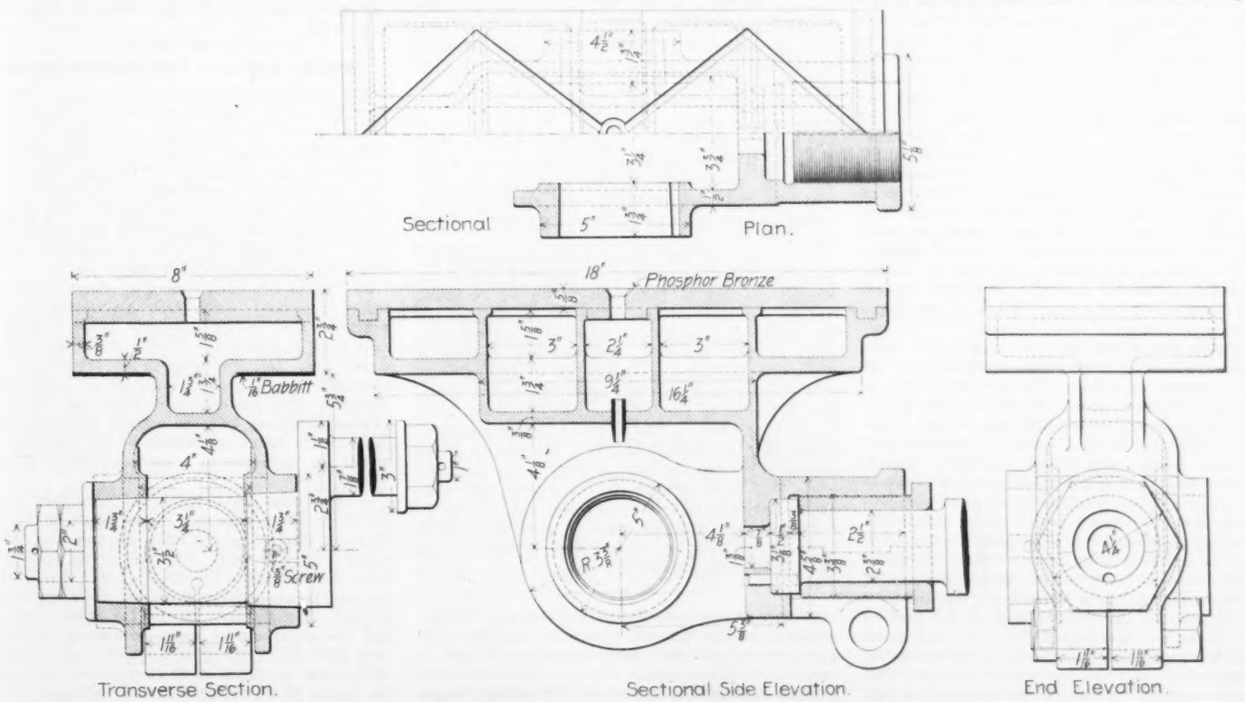


FIG. 5.—DETAILS OF DEAN CROSSHEAD FOR BALANCED LOCOMOTIVE.

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At least a half a dozen cities—or, more properly speaking, the newspapers in these cities—are exerting a large amount of energy in advocating their respective advantages as sites for a Government armor-making plant. It is well enough to "take time by the forelock," as the saying is; but at the present time booming Buffalo, or Waukegan, or Mulligan's Cross Roads as the site for a Government armor plant appears to us highly ridiculous. The Expert Board now in session is merely inquiring into the feasibility and economy of establishing a Government plant; and even in the event that it should favor such a scheme, it would be a good while before Congress could act on the proposal, and there are probably as many chances that it would put a quietus on the plan as that it would appropriate the several odd millions which would be required for a plant to make first-class armor for all classes of naval vessels.

It is very likely true that the armor-plate contractors are making large profits on their work at present prices; but it by no means follows that it would pay the Government to invest in an armor plant. If such an investment had been made seven or eight years ago, before the armor was purchased for the new naval vessels, it would, perhaps, have been highly profitable; but unless we are going on to enlarge our navy to compete with the chief European powers, it is difficult to see what a Government armor plant would have to do, two or three years hence. Besides all these considerations, excellent naval authorities are of the opinion that the torpedo boat, and not the battle-ship, is to be the naval vessel of the future; and it is by no means sure that the submarine torpedo boat may not put an end to all vessels of war, save, perhaps, the very smallest and swiftest. We mildly suggest, therefore, that the cities which are making such a fuss over their unparalleled advantages for the Government armor plant should hunt up some more profitable diversion.

Our editorial on "Difficulties in the Use of Water-Power under High Heads," in our issue of July 8, brings us a letter from a well-known engineer who suggests that besides the methods suggested by us for overcoming these difficulties, he would propose two others: (a) To have the units in the power station of not too large size, and (b) to use storage batteries into which all surplus electricity developed by the generators would be discharged when the load on the generators fell off.

As a purely theoretical matter, both these propositions are doubtless sound; but when we extend the theory to take into account some of the practical conditions met with in a water-power plant, we doubt whether either of these measures will commend itself to an engineer, except possibly under isolated and unusual conditions.

Let us take first the proposition to use water-wheels and dynamos of small size. Then it is possible for the operator in charge to vary the number of wheels in service according to the load on the station. As the load falls off he stops one or more units so that the load on those still running will approximate to that at which they will run most economically. With a water-power station carrying a large load of incandescent lights this would be feasible enough, for the changes in load are, as a rule, slow enough to permit the operator to make the necessary changes in the station. But it could not be carried very far without loss in dollars and cents. As a rule large size water-wheels and large size dynamos are cheaper for a given output than small machines. Again, attendance is a large item in power station expenses, and attendance is very little more for a large machine than for a small one. The designer of a power-station wants units of a size that will give lowest first cost and lowest cost of operation.

Will it pay to choose smaller sizes on account of the matter of regulation? Evidently not, for in any station where the load changes are sufficiently slow to enable a man to adjust the station to them by shutting down and starting up machines, automatic governors will take care of these changes without any difficulty. It is the sudden and considerable changes of load that make all the trouble in water-wheel governing, and in the use of water-power under high heads, and where these occur it does not appear to us practicable to shut down and start up units to offset their effect.

Our correspondent's second suggestion, the use of storage batteries, is also, it seems to us, commercially impracticable. Suppose a water-power station is subjected to such sudden fluctuations of load that trouble is found in governing. As we pointed out in our former article, the use of deflecting nozzle governors meets every requirement save that it wastes the water. Would it pay to put in a storage battery to save this wasted power? Possibly it might in some exceptional case where power is exceedingly valuable; but in the vast majority of plants we believe the storage battery would cost ten times as much as the power it saved would be worth.

It is true that the actual amount of power required to be stored is not large; but the size of the storage battery in this case would be governed not by the total amount of power stored, but by the ability to absorb for a short time electric currents of large quantity. For example, suppose a water-power station is running an electric railway. If a storage battery is to enable the water-wheels and dynamos to run at practically uniform load, it must be able to take without injury one-third to one-half the current output of the station. This means a storage battery of very large size and cost. This is, we believe, the real reason why storage batteries have never come into use in electric railway power stations, save in possible isolated cases, while they are now in very general use in electric lighting stations.

As noted more fully in another column, the Administration has decided to require candidates for the position of Supervising Architect to take a competitive examination. We have more than once pointed out that the system of civil service examinations, while admirably adapted to aid in the selection of candidates for subordinate positions in the Government service, is apt to prove seriously defective when it is used to select candidates for the highest positions. The examination of candidates for the position of Supervising Architect may seem at first sight to be another case of this sort; but there are some features of this examination which are notably different from the ordinary civil service examination. A large part of the work to be done consists in the preparation of original papers on subjects which are calculated to reveal as much as possible of the writer's fitness, or unfitness, for the position of Supervising Architect.

It may be said, and probably with much truth, that any such examination is a very imperfect method of distinguishing the men best fitted to fill the position; but the real question is whether it is any more imperfect than the methods of selection which have been used in the past, or which are actually open to the appointing officers in the absence of some form of competitive test. In the past, as is well known, this office has been a part of the "spoils" of the party in power. The candidate who could bring the largest amount of influence to bear upon the appointing power received the prize.

And what, let us candidly ask, could Secretary Gage do differently from what has been done in the past in the absence of some such examination as he has ordered. Possibly (though not probably) he may have among his personal acquaintances some architect whom he knows is competent to fill this very responsible position, and who is at the same time willing to accept the small salary which the office pays. But were Secretary Gage to appoint such a man, a cry would immediately go up that he was using his high position to put his friends in comfortable berths. Suppose, on the other hand, that he attempts to choose candidates for the position on the strength of the recommendations they bring. This means wading through a mountain of letters and testimonials from Congressmen, Mayors, office holders of every class, political leaders of high and low degree, and various other persons not one in a hundred of whom are personally known to the appointing power. When we consider also that probably not one in a dozen of those who endorse a candidate really know enough about him to warrant their recommendation, it seems clear enough that this is a very imperfect method of choosing a candidate for an official position. We are inclined, therefore, to commend the wisdom of Secretary Gage in ordering a systematic test of the abilities of those who seek to fill the office of Supervising Architect.

RIPARIAN RIGHTS IN UNDERGROUND WATERS.

The English common law, which is so largely the basis on which personal and property rights in the United States are founded, holds that the water percolating through a gravel or sand formation underlying any property, or through any formation by undefined channels, is practically a part of the land; and, as a consequence, all property rights in this water remain with the owner of the land. This right, however, is qualified by the equal right of all adjoining land owners.

So long as the chief source of water supply was from individual wells and population was so scattered that the underground supply was in excess of all demands, the justice of this law was unchallenged. But the growth of population, and especially the increasing number of public water supplies, with underground water as the only available source, have so altered previous conditions that a strict application of the old law often works an injustice to some community or individual.

In the United States local conditions very largely affect the law of riparian rights. Thus, in the New England States, where mills abound, the law of water rights is quite different in its application from the practice in the State of New York, where the canals make large demands upon the flowing streams of the state. In the far West, irrigation and the great use of water in mining operations have affected in still other ways the interpretations of the law of rights in flowing water. But while the rights to water from surface streams, or from any defined channel, have been in the several sections pretty well settled, the rights to underground percolating water have not yet been long enough a question of legal dispute to establish any well defined practice, and any information on this head is for this reason of interest.

As showing the injustice of the old English common law relating to underground waters when applied to modern conditions, a paper lately read before the Institution of Civil Engineers, by Mr. James Mansergh, Vice-President of the Institution.

is pertinent. This paper is upon "The Law and Allocation of Underground Water," and its chief points may be briefly set forth as follows: In 1891 the Corporation of Newark, England, sunk a well into the pebble beds of the New Red Sandstone formation, at Farnsfield, and obtained a sufficient and satisfactory water supply. The Corporation of Nottingham, and five small villages in the same neighborhood, are also supplied by wells sunk into this same formation, and the aggregate daily amount pumped from all these wells was six or seven million gallons. These pervious pebble beds have a total area of about 100 square miles; and borings show that they are about 400 ft. deep near Nottingham, and thicken towards the north. The surface formation overlying these beds is a much broken and porous rock, permitting the local rainfall to enter freely into the pebble strata below. The principal stream in this region is the Dover Beck, which was once 13 miles long, and has been reduced 3½ miles in length by the pumping operations of the last 20 years, according to the claims of the riparian owners.

No special complaint arose, however, until last year, when the Corporation of Nottingham applied to the Local Government Board for authority to sink new wells to supply several other parishes, with a total population of about 3,000. As one of these proposed wells would be located only 2½ miles from the works of the Newark Corporation, the latter made serious objection, and finally asked Parliament to grant it a protective zone of four miles radius about its Farnsfield well. This zone would have covered one of the proposed Nottingham wells, and the Corporation of Nottingham also petitioned Parliament for authority to sink three wells in practically the same territory over which Newark sought control. Both bills were strongly opposed by other local authorities in the neighborhood, and especially by the riparian owners on the Dover Beck, who claimed that their property was being unduly drained by the town wells. A long and expensive argument before Parliament followed; and the Newark bill was finally granted, but with a protective zone extending only to the supposed limits of the present supply. The Corporation of Nottingham was empowered to sink only one well, remote from Newark's territory.

This decision, seemingly a just and equitable one under the conditions, was directly contrary to the English law as hitherto interpreted, says Mr. Mansergh; and it may be cited as another case where Parliament has protected the people against the injustice of their own law. Under the common law, the Corporation of Newark would have had no redress, even if the Farnsfield well had been drained by the well of the rival corporation and its pumps left in the air. Its only remedy for the lost supply would have been to sink its well deeper and to lower its pumps. The reason for this, under the law, would be that the authorities of Newark could not prove that there was any defined channel leading the water from one well to the other. For the same reason riparian owners could not legally claim damages for the lowering of a stream and the undue drainage of pasture lands by the operation of pumping from wells remote from the stream.

This is the law as set forth in the judgment of the House of Lords in the case of Chasemore vs. Richards, the only case in which this question of right in an underground water supply has been fully threshed out in the English courts. The head notes to this case, as given by Mr. Mansergh, are as follows:

> No use of property which would be legal, if due to a proper motive, can become illegal because it is prompted by a motive which is improper, or even malicious. The owner of land containing underground water which percolates by undefined channels and flows to the land of a neighbor, has the right to divert or appropriate the percolating water within his own land, so as to deprive his neighbor of it. And his right is the same whatever his motive may be, whether bona-fide to improve his own land, or maliciously to injure his neighbor, or to induce his neighbor to buy him out.

Mr. Mansergh cites an old case where the water in the plaintiff's well at his brewery had been polluted by the percolation of foul matter from a disused well several hundred yards away. The first court decided that the brewer had no redress; because, there were no rights in underground water, and, therefore, there was no obligation on the part of the other party, to deter him from turning an unused well into a cesspool, and so injuring his neighbor's well. It may be said, however, that this decision was properly reversed by a higher court; but rather in accordance with common justice and common sense than to accord with the strict tenor of the English law.

In the case of surface waters, the law, in England and in America, is clear, righteous and intelligible. It says, briefly, that a man must allow the water flowing through his property to pass on to his neighbor, down stream, unpolluted and practically undiminished in volume. But he may have the fair and reasonable use of this water in its passage through his land. In the case of underground water the law denies redress to an injured party when he cannot prove a well-defined channel of communication between his own well and that of his neighbor. In this connection the law divides water courses into two distinct classes; those having known and defined channels, whether on the surface or subterranean, and those having unknown and undefined channels. The latter definition applies to percolating waters which are assumed to ooze through a porous soil in varying quantity and in uncertain directions. The law assumes that such water is part of the soil; and upon the principle that the owner has the land, even to the sky, and can build as high as he pleases, and also owns to the lowest depths, and can dig as deep as he pleases, this undefined water supply is his also, to do with it as he may. But while this is the law, its strict application to all cases alike may sometimes give rise to exceedingly knotty legal problems; and the City of Brooklyn has a case of this kind on hand at present.

All of the water used on Long Island, other than the rain water stored in household tanks, comes from saturated beds of gravel and sand, lying at the foot of an impervious backbone of boulders and clay and resulting from the rearrangement of an original glacial deposit. This pervious formation, underlying gently sloping plains of considerable area, catches and stores a considerable percentage of the rainfall upon its surface, and is thus so saturated that there was originally a comparatively constant flow through it towards the sea with a permanent water slope of about 12 ft. per mile. The streams on Long Island are fed by the rainfall "run-off," and by springs having their source in this saturated bed.

These were the original conditions; and wells sunk in this saturated bed gave almost everywhere an abundant supply of good water. But, commencing about 1860, the city of Brooklyn began to draw heavily upon this source for a public supply; and by impounding reservoirs on the streams and by conduits sunk deep enough along the southern shore to intercept the seaward flow of the underground water, it gathered and carried to Brooklyn an amount of water that now exceeds 100,000,000 gallons daily. To meet a constantly growing demand, it has been extending its conduits until these are now about 20 miles long, and in recent years it has increased its draft upon the underground water by sinking pipe wells and connecting these with suction pumps. But with the growth of Brooklyn, the country to the east of it, on Long Island, has developed and towns of considerable size are growing up, dependent also upon this same saturated bed for a water supply. Under an excessive demand the normal level of the water table is being steadily lowered, and the time has arrived when the question of the legal right to this water, remote from the city of Brooklyn, becomes prominent.

Up to this time the common law has been held to apply strictly to the Long Island supplies. The city of Brooklyn has gone on collecting water from these underground beds, and the owners of property bordering streams which diminished in flow or dried up as a result of Brooklyn's appropriation of their underground sources have received no compensation. Recently, however, a test case has been placed in the courts, and it is now before the court of last resort, in which it sought to overthrow the old common law and to compel the appropriator of underground waters to pay for damages suffered by riparian owners, just as he would be compelled to do if he appropriated the water of a flowing stream.

In the case in question one, Walter R. Smith, sued the city of Brooklyn for the drainage of a stream and pond upon his property by the sinking of driven wells in his immediate neighborhood. His complaint was dismissed by the trial court on the ground that, while the city did not seriously deny that the water was taken by its machinery, it denied liability under the decision of Judge Peckham, in a previous case, that "an owner of soil may divert percolating water, consume, or cut it off with impunity." This was in strict accord with the old common law, so far as it went; but Judge Hatch, of the Appellate Division of the Supreme Court of the State of New York, reversed this decision for reasons given, and the case is now before the Court of Appeals.

The conditions of the case may be briefly stated as follows: For the purposes of water supply to Brooklyn, the city authorities excavated a trench, 27 ft. below the surface of the ground, at Freeport, on the line of its conduit, and placed in this trench a box intended to intercept and carry water. The city also sunk, at the same place, a number of pipe wells and connected them with a powerful steam suction pump; and from one of these pumping stations, the average quantity of water taken, in 1895, was 36,421,147 U. S. gallons daily. The plaintiff occupied a farm near Freeport, and upon this farm were a stream, and also a pond formed by a dam which had been in existence for over 50 years, with plenty of water in them the year round. The pond was about 2,400 ft. from the city conduit, and the bottom of the latter was 16.8 ft. below the bottom of the pond, with all the intervening soil of a sandy and gravelly nature. The supply of water in the stream and pond began to fail soon after the city conduit was completed, and it entirely disappeared when the pumping station at Freeport was put into operation, and both stream and pond have remained dry since.

Under these conditions Judge Hatch holds that "the evidence is abundant to warrant a jury in finding that the disappearance of the brook and pond is due to the drainage of the territory where plaintiff's farm is situate, and is caused by the conduit and wells of the defendant in connection with the suction power applied thereto." Judge Hatch rules that the old English law does not apply here; for while the city owns the land, it did not build the structures upon it for the use and enjoyment of that land itself. It used the land to gather and carry water to a distant place, and for the benefit and profit of strangers who had no claim upon it, as against the plaintiff. The Judge claims that the right which exists and has been upheld, relates to the beneficial use of the land for some purposes for which the land can be used, connected with its enjoyment as land for the ordinary purposes of agriculture, mining, domestic use, or improvement, either public or private. He concludes by saying that all legal writers admit that property rights exist in percolating waters of as high a character as in the land itself; and that such water is, in fact, a part of the land; but he also deems it monstrous to assert that one land owner may deliberately and intentionally erect works for the purpose of draining the land of another of its percolating water and thereby destroy streams, springs, ponds or wells, and be supported in so doing upon the theory that it is in the exercise of a legal right to the use of the land.

It should be said that in the various newspaper comments which have appeared upon this case its importance has been over-estimated, and it has been assumed that its decision against Brooklyn would mean a general abandonment of underground sources of water supply. This is, of course, an unwarranted view of the case. A decision adverse to Brooklyn would probably go no further than to establish the principle that if an appropriator of percolating underground waters can be shown to have injured any stream, spring or other "living" water, he will be responsible for actual damages sustained by the riparian owners upon such living waters. A decision to this effect would simply place underground sources of supply upon the same plane with other sources. No city expects to take the waters of a stream for its use without compensating those whose property rights are thereby injured. As a matter of equity it should be equally ready to make good the results of its action when it drains underground waters.

LETTERS TO THE EDITOR.

A New General Formula for Determining the Unit Stresses in Masonry Structures.

Sir: Mr. E. Sherman Gould's letter published in your issue of July 1, and commented upon by Mr. Israels in the issue of July 22, has suggested the following to me: Assuming with Mr. Gould a horizontal force in addition to the weight of the mass, we do not have the condition his formula gives, viz.: a uniform unit pressure over

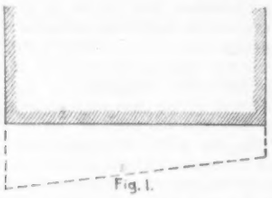


Fig. 1.

either segment of the base; but the unit pressure varies from one toe to the other, as indicated in Fig. 1, which is similar to Mr. Israels' Fig. 2. The ordinates from the base to the sloping line give the unit pressure at any desired point. That this is a fact, and not a "plausible guess," may be shown as follows:

When a homogeneous mass such as we have assumed is acted upon by a horizontal force there arise, in addition

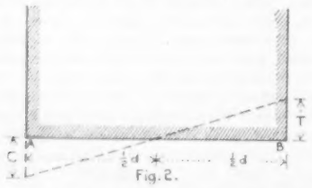


Fig. 2.

to the uniform unit pressure upon the base, strains due to flexure, these strains being equal in intensity and opposite in character at the toes; in other words, we have a beam under transverse load. Fig. 2 shows the line of variation of these strains, T being unit tension, C unit

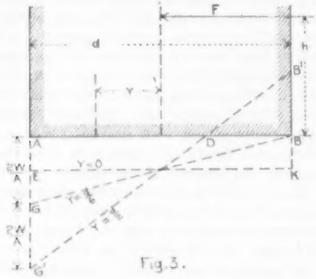


Fig. 3.

compression, and T = C. Hence, in the mass assumed we have at A the unit pressure due to the vertical weight, increased by C, and at B the same unit pressure, decreased by an equal amount T.

Referring to Fig. 3, and assuming for present purposes a rectangular section:

Let W = weight of the mass.
AB = d.
A = area of base = bd (b being the dimension perpendicular to d).
P = unit pressure due to W, when applied at the centre of the base: P_a = unit pressure at A due to resultant of horizontal and vertical forces.
P_b = the same at B.
S = unit strain due to flexure.
R = moment of resistance of section bd.
M = moment of F = P_b = Wy.
y = distance from centre of base to centre of pressure.

$$P = \frac{W}{A}, \quad P_a = \frac{W}{A} + S \text{ and } P_b = \frac{W}{A} - S$$

$$S = \frac{M}{R} = \frac{Wy}{R}$$

$$\therefore P_a = \frac{W}{A} + \frac{Wy}{R} \qquad (1)$$

$$\therefore P_b = \frac{W}{A} - \frac{Wy}{R} \qquad (2)$$

When $y = \frac{d}{6}$

$$P_a = 2\frac{W}{A} \text{ and } P_b = 0$$

All values of y greater than $\frac{d}{6}$ give negative values for P_b, showing tension on that side. This is the familiar "principle of the middle third," which explains why the center of pressure should not be allowed to pass beyond the limits of that third. GB in Fig. 3 shows how the unit pressures vary in the case considered. The maximum value of y is evidently $\frac{d}{2}$, which substituted in (1) and (2) gives

$$P_a = 4\frac{W}{A} \text{ and } P_b = -2\frac{W}{A}$$

The line G'B' shows the variation of unit pressures, there being tension from D to B.

From the similar triangles D B B' and D A G'

$$\frac{DB}{DA} = \frac{BB'}{AG'} = \frac{1}{2}, \text{ or } DB = \frac{1}{2} DA$$

Showing that with the centre of pressure at A the unit pressure at this point is four times what it is under symmetrical loading, and that the total downward pressure is carried on $\frac{2}{3}$ of the base.

Formulas (1) and (2) are thus seen to be applicable to all cases involving rectangular sections. They may be applied to any form of section by substituting proper values for A and R. Very truly yours,

R. C. Strachan.

31 Broadway, N. Y, July 30, 1897.

An Erroneous Use of Euler's Formula.

Sir: Euler's formula for the strength of columns seems to be a good example of the irony of applied mechanics. It is forever leading engineers and others astray and producing an apparent conflict between theory and practice. While it is only the purely theoretical column formula which is true in practice, it applies only to such great lengths $\left(\text{high values of } \frac{}{r^2}\right)$, that it is of no practical value, and it could never be used in practice. The use of it in practical designing leads to most vicious and absurd results, as is well illustrated in your issue of July 29, p. 79. That a college professor should have been the victim in this case makes the case all the more striking, since these are men to whom the profession looks for intelligent guidance in such matters.

In the case of a piston or connecting rod the ratio of length to the least radius of gyration is small, probably about 40 in the former case, and perhaps 60 in the latter. To apply the Euler formula to such a case, without working out the theoretical ultimate stress per square inch as given by the formula, leads to dangerous designing, even when very large factors of safety are employed. Thus in the case of a piston rod, fixed at one end and pivoted at the other, the theoretical unit stress is

$$p = \frac{P}{A} = \frac{9\,\pi^2\,E}{4\left(\frac{l}{r}\right)^2} \qquad (1)$$

For $\frac{l}{r} = 40$, and E = 30,000,000, we obtain from this p = 420,000 lbs. per sq. in., as the ultimate strength of the column. Evidently it would require a very large factor of safety, indeed, to make a safe design in this case. If the factor of safety were really but 15, as computed by Professor Barr, the working stress per sq. in. would still be 28,000 lbs. per sq. in., which being reversed a practically infinite number of times would soon fail, even if made of steel. As a matter of fact, the factor of safety in this case for the average practice given by Prof. Barr is nine times 15, or 135, when compared with the computed strength, using the correct form of the Euler formula.

A similar criticism applies to the connecting-rod discussion. In fact, the Euler formula should never be used in machine design, since it applies only to values of $\frac{l}{r}$ over 100 for pivoted ends, and over 150 for flat ends, and in machine construction.

J. B. Johnson.

Washington University, St. Louis, Mo., Aug. 4, 1897.

(In accordance with our usual custom, we submitted a proof of the above letter to Prof. Barr and append his reply herewith.—Ed.)

Sir: Through the courtesy of the Editor, I have been given an opportunity to reply to the above criticism of a paper which I recently read before the American Society of Mechanical Engineers, an abstract of which appeared in the Engineering News of July 29. I regret that Professor Johnson, who is a member of the Society, did not offer his objections, as a discussion of the paper, so that the matter might appear in the Transactions.

I am well aware that there are restrictions surrounding the application of the Euler formula, and I know of no one better qualified to define the limits than the writer of the above communication. It is quite possible that I am in error in applying this formula to the piston rods and connecting rods of engines, but there seems to be certain extenuating circumstances which I beg to submit in my defense.

In the first place, I will discuss, as briefly as possible, the value of the coefficient used in the formula for piston rods. Professor Johnson says that this should be $\frac{9}{4}$ for a piston rod "fixed at one end and pivoted at the other." I shall not attempt to contest this value for these end conditions which he assumes. My paper, as presented to the Society, and also the abstract in Engineering News, contains the following brief statement of the considerations which led me to assume somewhat different end conditions for the strut: "The piston rod is considered as coming under the case in which the strut is fixed at one end and free at the other. It may be urged that the guides constrain the outer end; but many forms of guides are poorly adapted to exert constraint against lateral flexure, and it is better to provide the slight increase of diameter required to avoid such side pressure on the guides." In other words, I suggest designing the rod for sufficient rigidity to avoid a tendency to crowd against the guides and cramp the crosshead under the strut action; not depending upon the guides to keep the outer end in line. With the end conditions which I assumed, I believe the coefficient ¼, and the factor of safety of 15, are correct. The coefficient of ¼ instead of $\frac{9}{4}$ as given in equation (1) of Professor Johnson's letter, makes the stress less than 47,000, instead of 420,000; and with the factor of safety of 15, the working stress becomes 3,125.

Had I taken the end conditions suggested by Professor Johnson, I should have obtained his factor of safety of 135, which covers a contingency for which I endeavored to provide by my assumptions as to the probable end conditions. Of course it is not to be expected that any assumptions which may be made as to end conditions will be fully realized in such an application. In such cases, the best that can be done is to assume the most unfavorable conditions against which the designer may be reasonably expected to provide, and then to use a factor of safety to cover other contingencies. The farther the rational analysis is carried, if it does not exceed the bounds of reasonable probability, the smaller the element of ignorance in the factor of safety. Perhaps my view as to what the end conditions may approach, constitutes an error in judgment calculated to introduce "vicious and absurd results;" but I am still inclined to adhere to it rather than to treat the piston rod as fixed at one end and pivoted at the other.

While the issue which Professor Johnson raises is the propriety of using the Euler formula at all, this depends largely upon the validity of my assumptions as to the end conditions. Assuming these conditions to apply to the case of the piston rod, we will now examine for limits beyond which the Euler formula is applicable. In a work on "Modern Framed Structures," by Professor J. B. Johnson, of Washington University (page 146), I find: "The shortest length of column which could act in this way (i. e., fail by bending alone) would be found by making p as large as possible, or when p = f = elastic limit." In a more recent work by the same author, I find the elastic limit for Bessemer steel, under compression, given at above 41,000 lbs.; and also the statement: "It will not be appreciably in error to call the modulus of elasticity of steel 30,000,000." To be conservative, p, the stress at the elastic limit of steel piston rods will be taken at only 30,000 lbs.; and E will be taken at 30,000,000. In the Euler formula corresponding to the end conditions which I have assumed in this work:

$$p = \frac{\pi^2\,E}{4\left(\frac{l}{r}\right)^2} \quad \therefore \frac{l}{r} = \frac{\pi}{2}\sqrt{\frac{E}{p}} =$$

$$\frac{\pi}{2}\sqrt{\frac{30{,}000{,}000}{30{,}000}} = 50.$$

For a solid circular section, the radius of gyration, r, is ¼ d, in which d is the diameter of the rod. Hence:

$$\frac{l}{r} = \frac{4\,l}{d} = 50. \quad \therefore l = 12.5\ d.$$

From the above, it would appear that the Euler formula may be used when the length of strut exceeds 12.5 diameters. This would include nearly all of the piston rods of long stroke slow speed engines; while many of the high speed engines would fall somewhat below this limiting ratio.

To illustrate the degree of viciousness in using the Euler formula for a short stroke engine, assume an engine 16 × 20 ins.; boiler pressure, 100 lbs.; steel piston rod, ultimate strength 60,000 lbs.; factor of safety 15. The formula of my paper, for a factor of safety of 15 on the basis of my analysis of the case, gives:

$$d = 0.145\sqrt{D\,L}; \text{ or } d = 0.145 \times 17.9 = 2.68.$$

*Prof. Barr had unity in place of 9 in this equation, which error made his results seem more reasonable.

Considered as a short strut, the load is 20,000 lbs., and with a factor of safety of 15, the working stress should be 4,000 lbs., hence the cross section of the short strut should have an area of 5 sq. ins.; o rthe diameter should be 2.52 ins. While this rod may not be quite long enough to yield by pure flexure, it is rather long for a simple short strut and the error resulting from treating the rod as a long strut is on the side of safety.

In regard to connecting rods, I must content myself with the statement that these often buckle in service, but seldom, if ever, fail by direct crushing. I have already taken too much space to warrant any separate discussion of connecting rods. These, in common with most of the members of a steam engine, cannot ordinarily be subjected to rigid analysis, and in all such cases, the analysis can only be in the line of prevailing tendencies.

Ithaca, N. Y., Aug. 14, 1897. John H. Barr.

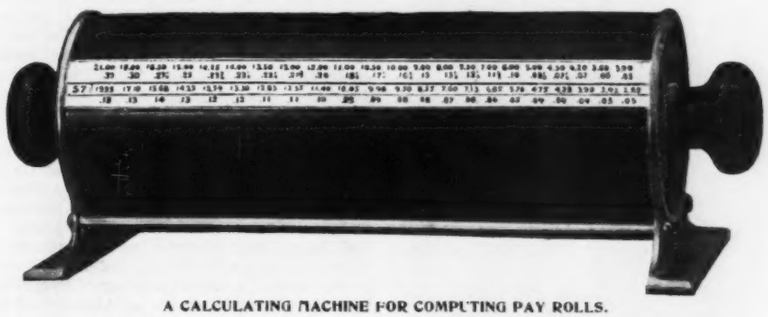
Notes and Queries.

W. D. H. (Montreal) wishes to know whether a car transfer or ferry has ever been used for electric railways, the ferry-boat or barge being hauled across the river by a hoisting engine operated by an electric motor.

A CALCULATING MACHINE FOR COMPUTING PAY ROLLS.

In the making up of a pay roll as at present done, with few exceptions, each man's time must be multiplied by his rate of pay per hour. Where fractions appear, either in time or rate, a considerable amount of mental effort and time are necessary and a considerable chance of error is introduced.

The device illustrated below is intended to obviate these chances of error and greatly economize the labor required for computing wages. Instead of the bookkeeper each week figuring out certain combinations of so many hours at such a rate, the manufacturers of the machine have calculated all numbers of hours, from one to three hundred per week, at all rates of pay, from $3 to $21 per week, and arranged these values in such a way that the operator may set the machine and read the results directly with no mental effort or chance of mistake. The auditor of a large New Jersey railroad company which has given the machine a thorough trial, states that one man with the calculator can do the work of four men without it in making out pay rolls.



A CALCULATING MACHINE FOR COMPUTING PAY ROLLS.

As can be seen from the cut, the machine consists of a cylindrical metal case, with a narrow slit extending its whole length, supported at the ends by two light standards. Along the upper edge of the slit is a celluloid strip with two rows of figures, the upper being dollars per week and the lower cents per hour. Another line of figures just below gives cents per half hour. Inside the casing is a cylinder of light wood to which the projecting knobs are fastened for convenience in turning. Around the left hand edge of this inner cylinder is a series of prominent numbers, usually from 1 to 64, which indicate hours worked per week. On the same line with each of these and extending the whole length of the cylinder are rows of figures which are the results of multiplication spoken of before, and are all covered by the casing but the line under the slit. To make clear the method of operation, assume that a man works 32 hours during a certain week at the rate of 23½ cents per hour, what should he receive? Turn either knob until 32 appears on the left, then glance along the upper scale until 23½ is reached and directly below on the cylinder will be found $7.52, which is the amount due. The machine is about 12 ins. long, stands 6 ins. high, is neat in appearance, and well made. The machine is sold at a moderate price, and will prove of great value to contractors, railways and any employer of labor on any considerable scale. It is manufactured by the Lightning Calculator Co., 120 Liberty St., N. Y., who furnish cylinders for standard rates of wages, or with special scales where required.

THE PHILADELPHIA MUSEUMS.

The development of the foreign commerce of this country has made it increasingly important that business men and manufacturers shall be able to obtain readily detailed information respecting the resources, natural products, manufactures, traffic facilities, and trade requirements, etc., of foreign countries, and the city of Philadelphia has, within the last few years, established a large institution for this purpose which is known as the Philadelphia Museums and is supported by the city and state and a number of influential societies and individuals. The objects of the institution, as stated in a descriptive pamphlet, are as follows:

1. To bring before our manufacturers, dealers and consumers, all the varied products of the world, that they may make the best selection for their own special interests.

2. To publish concerning these products all scientific and useful information which may aid the manufacturer and consumer in their choice.

3. To place on exhibition manufactured products from foreign countries, in order that our manufacturers may be properly informed concerning all markets which they ought to enter or control.

4. To gather from all parts of the world, and to make immediately available to our business men, full and specific information concerning trade opportunities.

The immense collection of exhibits of the varied products of the world at the Columbian Exhibition in 1893 suggested to the promoters of this project the possibility of making a permanent collection of this character, and in October, 1893, the City Councils of Philadelphia passed an ordinance appropriating $100,000 towards the necessary expenses. Extensive exhibits were secured from Australia, Japan, India, Africa and the Central and South American states, and these have been supplemented by the work of special commissions and agents in foreign countries. The collections were stored in the City Hall and other buildings until the proper quarters could be secured. In August, 1895, the old offices of the Pennsylvania R. R., on South Fourth St., were leased for a term of five years, and these offices afforded about 200,000 sq. ft. of space, included in more than 100 rooms.

In June, 1894, the City Councils passed an ordinance creating a Board of Trustees to organize and direct the institution. In June, 1895, they passed an ordinance granting the trustees eight acres of land, and in 1896 eight acres more were added. On this land buildings will be erected, the plans of which have already been prepared. From 1893 to December, 1896, the city had made appropriations aggregating $410,000, and during the present session of the Pennsylvania Legislature a bill was introduced asking for an appropriation of $500,000 for building purposes.

The Board of Trustees created under the ordinance of 1894 consists of the Governor of Pennsylvania, Mayor of Philadelphia, Presidents of Select and Common Councils of Philadelphia, President of the Board of Public Education of Philadelphia, the Superintendent of the Public Schools of Philadelphia, the State Superintendent of Public Instruction, and the State Commissioner of Forestry. All these are ex-officio members. All other trustees are life members of the Board, having been appointed by the Councils and approved by the Mayor. In order to conduct the work of the institution on a broad basis, a National Advisory Board was organized, which consists of members elected by the Chamber of Commerce, Boards of Trade and other commercial organizations throughout the country. Various commercial organizations of Mexico and Central and South American states have also accepted invitations to appoint delegates to serve on this Board. Individual business concerns throughout the country can secure membership on payment of a moderate fee, which entitles them to reports on the various markets of the world relating to their special interests.

The organization of the Museums is divided into the following departments:

(1) Department of Raw Products.—In this department all exhibits are arranged according to countries and according to kinds of products. Under the first classification a visitor may study the resources and commercial features of any particular country, and can ascertain the means of transportation and manner of communication with other countries of the world, while under the second classification a manufacturer of any one class of goods can see before him samples of the raw and finished material of similar manufacturers in almost every other country.

(2) Scientific and Experimental Department.—The object of this department is to make a careful study of the scientific and economic value of different products, such as tan-barks, vegetable fibers, gums and resins, etc. New articles will be subjected to tests to determine their commercial and practical value. This department will issue publications giving particulars of these researches, and will co-operate with foreign scientific bodies.

(3) Exhibit of Foreign Manufactures.—This is a collection of samples of merchandise now being sold in foreign countries, more especially in the markets of Mexico, Central and South America, Australia, South Africa, and other new fields now being opened to American commerce. The object of this is to show to the American manufacturer what his competitors are doing in the foreign trade of these countries and give him sufficient information to judge whether it will be advisable for him to attempt to enter any particular market. Novelties and improvements introduced by foreign manufacturers will be promptly noted.

(4) Commercial Library.—The library has already received many hundreds of publications relating to trade, commerce, and finance, including a great number of technical and trade journals, statistical publications, consular reports, government reports, etc. Books of reference in various languages, and business directories, are kept on file and carefully indexed so as to be readily available.

(5) Bureau of Information.—The work of this bureau is to bring together all possible information relating to foreign commerce, and to index and compile this information so as to make it readily accessible to each individual interest. The information obtained from trade journals and reports is supplemented by extensive correspondence, and by communications from about two thousand special correspondents. This bureau furnishes information as to prices of raw material in various countries, approximate quantity available, means and cost of transportation, and particulars of treaties, customs duties, rates of exchange, currency, freight rates, and systems of commercial relations. This bureau also furnishes regular monthly reports to manufacturers who are subscribing members of the Museums, and has at hand a very complete card index of all the prominent business houses in Australia, Japan, Africa, India, China and South America, these being arranged according to the lines of goods in which they are dealing. These card files are kept corrected to date and are loaned to the subscribers of the Museums.

The information collected and compiled by this bureau is distributed to the subscribers who pay

an annual fee of $50, which is the estimated price for copying all reports, for card files and postage. To casual inquirers, the bureau answers in every instance, if possible, the first inquiry without charge, but advises that any additional information must be procured by becoming a subscriber to the institution. All individuals who call personally at the Museums are given full access to information, free of charge, with such explanation as is found necessary and desirable. At the present time the officers of the Museums are as follows: Director, Wm. P. Wilson; Chief of Scientific Department, Gustave Niederlein; Chief of Bureau of Information, Wm. Harper. The officers of the Board of Trustees are as follows: President, William Pepper; Vice-President, Charles C. Cramp; Treasurer, Sidney L. Wright; Secretary, Wm. P. Wilson.

EXPERIMENTS ON THE REMOVAL OF IRON FROM GROUND WATER AT PROVINCETOWN, MASS.

Coke breeze as a filtering material to remove iron from ground water at Provincetown, Mass., has been tried experimentally with marked success. The tests were made by Mr. H. W. Clark, Chemist in Charge of the Lawrence Experiment Station. The water was passed through a small filter containing the coke breeze (screenings from commercial coke) to a depth of 3½ ft. A removal of 98% of iron in the applied water was effected while operating the filter at the rate of 1,000,000 gallons a day, and this was continued for several months. Later, a larger filter, 13.7 ft. in diameter, was installed at Provincetown (the small filter having been at Lawrence), but this gave only 93% removal at the rate of 1,000,000 gallons an acre a day. The coke layer was thinner here, and the water was not well distributed over the surface, resulting in uneven rates of filtration at different parts of the bed. Aeration, followed by filtration through sand, removed only 20% of the iron, when filtering at the rate of 1,000,000 gallons per acre per day, and 80% when filtering at one-tenth this rate. Long-continued aeration gave no better results, and it was finally determined that the aeration was of no value, for this particular water.

The efficiency of the coke is attributed by Mr. Clark to the chemical action of the metallic iron in the coke, changing the iron in solution in the water to ferrous, and then to ferric hydrate, in which latter form it is filtered out by the mechanical action of the coke. Mr. Clark also found that the passage of water through iron filings and turnings, with subsequent sand filtration, would remove the iron. This is similar to the Anderson process of treating water for ordinary purification, but this process has never been used to remove iron, so far as Mr. Clark knows.

The water at Provincetown is drawn from a system of 5-in. driven wells, having an average depth of 28 ft. The iron in the water has increased year by year since the wells were put in use, having averaged as follows: 0.1340 parts per 100,000 in 1893; 0.2212 in 1894; 0.3764 in 1895, and 0.4950 during a part of 1896. Provincetown, it may be added, is situated on Cape Cod, and is nearly surrounded by the sea.

The above information is extracted from a paper by Mr. Clark, printed in the Journal of the New England Water-Works Association for June, 1897. Mr. Clark informs us in a letter dated July 19, 1897, that with the introduction of better methods for distributing water over the larger filter no better results were obtained than formerly. This filter, however, was located in town, and received the water after having passed through the standpipe. A third filter, located at the pumping station and receiving the water just as it came from the wells, was operated for three months at a higher rate than the town filter and removed a much larger percentage of iron than did the latter.

JAMES ANDREWS.

Mr. James Andrews, who died, on July 6, at his residence in Allegheny, Pa., was the President of the Pittsburg, Iron & Steel Co., and for many years was prominently identified with some of the greatest engineering enterprises of the century. James Andrews was born, about 73 years ago, on Ingleston Farm, near the village of New Abbey, Dumfrieshire, Scotland. He was apprenticed as a lad to a bricklayer and stonemason, but came to the United States in 1840 and located at Pittsburg, Pa. After working some time at his trade, he embarked in the contracting business upon his own responsibility, with a full knowledge of the practical part of his business and a rare ability in handling men. In 1846 he carried out a contract on the old Pittsburg post office building under difficult conditions, and his success with that work brought him other contracts in tunnel and bridge building on the railways in the neighborhood of Pittsburg. He built the Steubenville bridge over the Ohio River. This work brought him into contact with Mr. James B. Eads; and these two remarkable men became associated in business, and when Mr. Eads had successfully worked up his project for the St. Louis bridge, the first to cross the Mississippi River, Mr. Andrews controlled the practical part of the execution of this great work. The deep pneumatic foundations of that structure, the largest and deepest yet built upon that system, were under the especial direction of Mr. Andrews. And their successful com-

James Andrews

pletion in the face of great and then untried difficulties, is said to have been largely due to his personal ability, energy and undaunted perseverance.

After the completion of this structure Mr. Andrews was associated with Mr. Eads in his project for opening the mouth of the Mississippi River by a system of jetties. And at the close of the long preliminary struggle in inducing the government to accept the plans proposed, Mr. Andrews was placed in charge of the execution of the work, and, after investing his own fortune in the enterprise, he again succeeded in obtaining the results sought for, and wealth and fame followed for both of the men to whom the United States is so largely indebted for this most important public improvement. Mr. Eads is entitled to all the credit for conceiving the plans, for successfully combating a strong opposition and by his personal magnetism and forcible presentation of engineering and commercial possibilities inducing others to take sides with him; but Mr. Andrews possessed rare powers of organization and had great executive ability in handling men and carrying on great works, elements which are essential to the success of any engineering enterprise.

After the successful completion of the Mississippi jetties, Mr. Andrews and Mr. Eads made together a tour of the world, and they were the recipients of many flattering attentions from foreign governments, and men of note. On their return to the United States these men embarked in a scheme to construct a ship railway across the Isthmus of Tehuantepec; and concessions were secured from the Mexican government, plans were perfected in all detail and work was actually started, when Mr. Eads' death occurred. The prosecution of work on the Panama Canal, and the pushing of the Nicaraguan Canal scheme raised strong opposition to the Tehuantepec ship railway, and the final refusal of aid by the government caused all active work upon it to be abandoned; though Mr. Andrews, to the time of his death, never failed to advocate the railway method of connecting the two oceans whenever the opportunity offered.

Mr. Andrews last great work, still unfinished, was the organization of the North River Bridge Co., for bridging the Hudson River at New York. He organized the company with $50,000,000 capital, and had complete plans prepared for a suspension bridge with phenomenal span, and depth of tower foundations. The business depression of the last few years interfered with the actual execution of this work; but much has been done in the way of securing legislation and in devising ways and means that may culminate in the near future in the erection of the world's greatest bridge.

In addition to these greater enterprises, Mr. Andrews was a very busy man in other directions. For many years he was a director in the Federal Street & Pleasant Valley Ry. Co., and he had much to do with the purchase of the old Moorhead & McCleane furnaces and iron works and their reorganization into the Pittsburg Steel & Iron Co. His two sons Eaves and Walter Andrews, assisted him in the management of these works. He was also one of the managers of the Western Pennsylvania Hospital and a member of the Executive Committee in charge of the insane asylum at Dixmont. In 1849 Mr. Andrews was married to Miss Maria Carson, of Allegheny, and five sons and three daughters survive him. With Mr. Eads, Mr. Andrews gave testimony some years ago on the then projected Manchester ship canal before a Parliamentary Committee. On Mar. 4, 1884, he was made an Associate of the Institution of Civil Engineers.

Personally Mr. Andrews was a modest man with a very high sense of personal honor and business integrity, and he possessed in a very unusual degree an organizing and executive ability in planning and carrying out large engineering enterprises. From his youth up he was a close observer of natural phenomena; and his knowledge of engineering principles, though self-acquired, was broad and well founded. He was especially versed in hydraulics and his judgment upon river and harbor work made him sought after as an expert in this field.

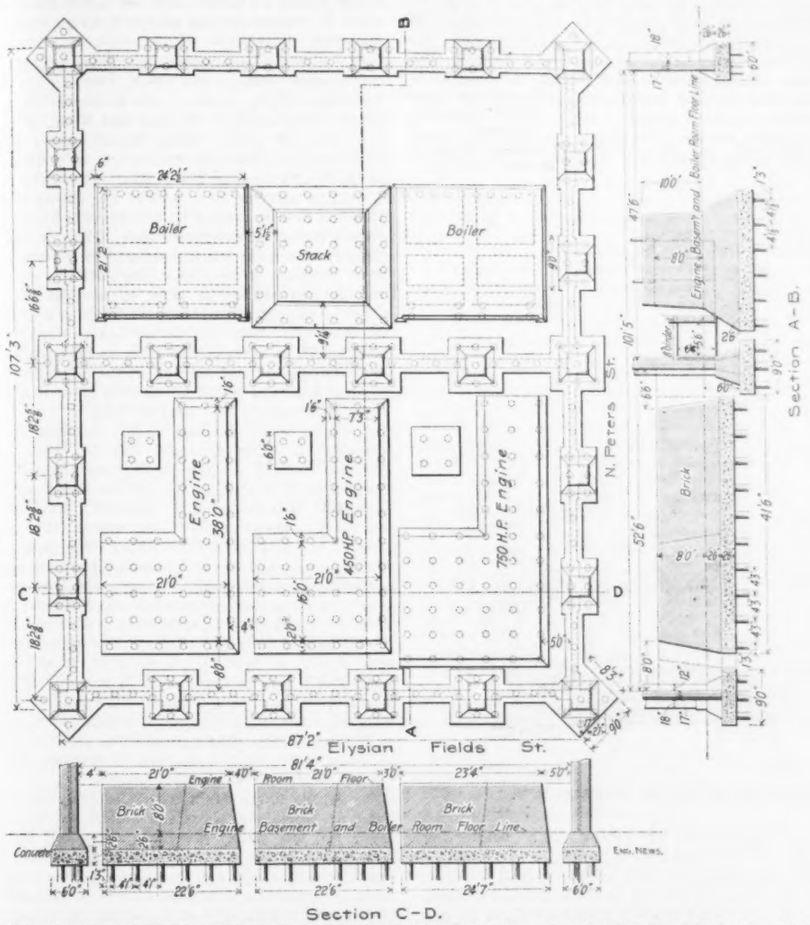
FOUNDATION FOR THE CANAL & CLAIBORNE ELECTRIC RAILWAY POWER HOUSE, NEW ORLEANS, LA.

A building foundation on soft ground which presents several features of interest has recently been completed in constructing the new power house for the Canal & Claiborne Electric Ry., at New Orleans, La. This building is located on the river front, which is mostly made ground, but where the new material is underlaid at a depth of about 35 ft., with a natural stratum of gravel and shells varying from 3 ft. to 7 ft. in thickness. The existence of this solid stratum determined in large measure the style of foundation adopted, which, as will be seen from the accompanying drawings, is composed of piles capped with 2 ft. 8 ins. of stone concrete. Separate foundations are used for the walls of the building and for the machinery, and also for each individual unit of the machinery, each engine, condenser and boiler being founded on a separate cluster of piles.

The power house is a stone and brick masonry structure 107 ft. 3 ins. long and 87 ft. 2 ins. wide, divided transversely by a wall separating the boiler room from the engine room and covered with a steel truss roof. The building walls are carried on 252 piles arranged as clearly shown by the draw-

ing. A separate cluster of 36 piles carries the smoke stack, which is of steel 125 ft. high, and is mounted on a brick base 10 ft. high. The three engines are carried on clusters of 45, 51 and 45 piles, respectively, and each condenser foundation has four piles. The two boilers rest on 36 piles each. Altogether, therefore, there are 477 piles in the foundations for the building and machinery.

The piles used were of yellow pine 50 ft. long, and of diameters at the butt of from 14 ins. to 16 ins., and at the top of from 10 ins. to 12 ins. These piles were driven into the gravel stratum, before mentioned, and their tops cut off at a uniform level. As indicating the character of the pile bearing it may be noted that while it was possible, with a 3,000-lb. hammer having a 30-ft. drop, to drive the piles from 4 ins. to 12 ins. at the last blow, yet after being allowed to rest a few hours it was not possible to drive the same piles more than ¼-in. with the same hammer and a 50-ft. drop. It was calculated that the resistance was approximately 600 lbs. per lin. ft. of pile, or about 15 tons per pile, and the maximum load per pile was made 8 tons. When composed of moving machinery the load was placed still lower to ensure a greater factor of safety.



PILE AND CONCRETE FOUNDATION FOR POWER HOUSE OF CANAL & CLAIBORNE ELECTRIC RY., NEW ORLEANS, LA.
Ford, Bacon & Davis, New York, N. Y., Engineers.

After the piles had been cut off to a uniform level the earth between them was excavated to a depth of 1 ft. below their tops. This earth was a kind of blue clay mud and very unstable. Therefore, to secure a satisfactory bond between it and the concrete capping the first layer of concrete was laid dry and thoroughly tamped into the soil, dependence being placed upon the water in the soil to wet the cement sufficiently to bring about the necessary set. This layer of dry concrete was composed of one part Dyckerhoff Portland cement, two parts sand and three parts of granite crushed to pass a 1½-in. diameter ring. On top of this foundation or "binder" layer the concrete of the same composition but mixed with water was laid to the dimensions indicated by the drawings. Especial care was used both in mixing and laying the concrete, and after finishing it was allowed to set for ten days before the brick work was begun.

With the preceding description and the drawings the construction will be quite clear, and it remains only to be noted that after six months' use of the machinery, and often with overloads amounting to 50%, the foundation has shown no undesirable action. The work of building the foundation and power house was done by Muir & Fromherz, of New Orleans, La., under the direction of Ford, Bacon & Davis, St. Paul Building, New York city, the engineers for the Canal & Claiborne Ry. We are indebted to the engineers for the use of the drawings from which our illustration has been prepared.

MICHIGAN STREET DRAWBRIDGE, BUFFALO, N. Y.

We illustrate herewith a double, hinged lift bridge recently completed across the Buffalo River at Buffalo, N. Y., which presents several novel engineering features in connection with its operation and construction. This bridge crosses the river near Michigan St., and replaces an iron swing bridge built about 25 years ago. The old bridge having become inadequate for the traffic, it was decided in 1895 to replace it with a new structure, and as the shipping interests urged that the new bridge should be a folding bridge of long span and capable of quick operation, general specifications for this type of structure were prepared by Mr. Samuel J. Fields, M. Am. Soc. C. E., then City Engineer of Buffalo. These specifications called for a clear span of 150 ft., a roadway 22 ft. wide, and two sidewalks 5½ ft. wide each, and required that the bridge should consist of two independent halves so hinged at the shore ends as to open vertically. The bridge was required to be opened in one minute. Under these specifications bridge builders were asked to submit plans and prices, and a large number did so. The plan finally adopted was one submitted by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis., and a contract was awarded to the same company to build the bridge exclusive of the foundations for $38,700.

The substructure plans were prepared to correspond with the superstructure plans. This sub-

Fig. 1.—Bridge Closed.

Fig. 2.—Bridge Partly Open.

DRAW BRIDGE OVER THE BUFFALO RIVER AT MICHIGAN ST., BUFFALO, N. Y.

structure, which consists of masonry resting on piles and grillage, was let as a separate contract by the city of Buffalo in the fall of 1895, and after many mishaps, litigations, etc., was finished by the contractor's bondsmen in April, 1897. Meanwhile

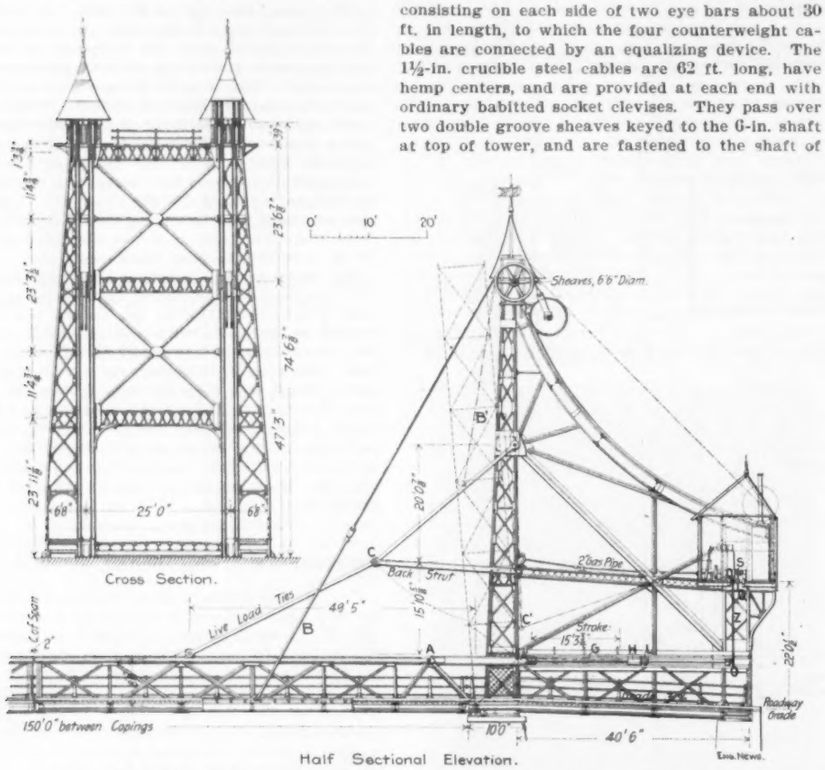


FIG. 3.—SIDE AND END ELEVATIONS OF MICHIGAN ST. DRAW BRIDGE, BUFFALO, N. Y.

the bridge company had manufactured and shipped a portion of the bridge material, which was stored at Buffalo from Feb, 1896, to Feb., 1897, when the erection of one side was commenced. This half was almost completed by April, when the substructure on the other side was ready. The bridge was then carried on to completion and opened to travel in the latter part of June, 1897. During the progress of the work on the new structure, the old swing bridge which had been temporarily set up a short distance down stream was opened for vessels 40 or 50 times a day.

The erection of the new bridge was accomplished entirely without falsework and without interfering with navigation. The trusses of the lift span, 77 ft. in length and 9 ft. high, were shipped in one piece, and the big tower legs, 75 ft. high and weighing 17 tons each, in the same manner. In the erection of the tower spans, counterweighted tracks, etc., a large frame bent 56 ft. in height running on the sidewalks of the tower span was employed and the iron-work of the swinging span which hinges at the foot of the tower by means of 8-in. pins in bronze bearings was put together and the oak floor laid while the trusses were in a vertical position. The photographs made by A. W. Simon, Buffalo, N. Y., Figs. 1 and 2, show the general appearance of the bridge in its closed and open positions, and the drawings, the arrangements of machinery, operating screw and strut, dead and live load ties, cables, sheaves, counterweights, engine-house, etc.

The live load ties, Fig. 3, consist of two 6 × 1⅛-in. eye bars laced, and hinged at ends and center. In order to accommodate the length of bars when the swinging span is in an upright position, the pin at the upper end of the live load ties is allowed a vertical motion of about 2 ft., and is arranged so that it is locked automatically when the bridge is in a closed position. This arrangement, in connection with the back strut, holds the live load ties in position and effectually prevents excessive vibrations which were feared on account of the long overhanging arms. The back strut is provided with a locking wedge at its rear end which is thrown into position when the bridge is down by a single hand lever in the engine-house.

The dead weight of each moving span is 60 tons which is carried by the dead load ties B (Fig. 3), consisting on each side of two eye bars about 30 ft. in length, to which the four counterweight cables are connected by an equalizing device. The 1½-in. crucible steel cables are 62 ft. long, have hemp centers, and are provided at each end with ordinary babitted socket clevises. They pass over two double groove sheaves keyed to the 6-in. shaft at top of tower, and are fastened to the shaft of the counterweights by means of a connecting hanger, as shown on plans.

The total counterweight of one side is 70 tons, each one-half, or 35 tons, is made up of ten large castings and of six smaller ones assembled upon a 6-in. shaft 8 ft. long. The ten main castings are 6-ft. 6 ins. in diameter and 5 to 7 ins. thick. Two of them are grooved to run upon the curved counterweight track. This track consists of two 60-lb. T-rails spaced 3 ft. c. to c., and supported by the girders, as shown on the drawing. A small adjustment is provided for by means of shimming plates under the curved rails. Calculations to determine the correct shape of the curved track were quite tedious owing to the fact that the back strut, live load ties, varying length and direction of the cables, etc., had to be taken into consideration. Fixed spans at shore ends are anchored against uplift by means of long anchor rods built into the masonry.

The power for operating the bridge is applied to the moving span at the hip A, through the operating strut B, by means of the screw G. This is a triple screw about 18 ft. long and 6 ins. in diameter. It has a ¾ × ¾-in. thread, and a 4½-in. pitch, and requires 46 revolutions, or a stroke of 15 ft. 3½ ins. to open the bridge. The screw itself is held in position by means of the thrust box H. This is a bronze casting with grooves to receive the collars turned on the screw shaft. The bronze nut through which motion is conveyed to the operating strut is mounted on a traveling carriage with top and bottom tracks to take up vertical reaction when operating strut is not working in a horizontal direction. Near the thrust box the bevel gear K (Fig. 4), is arranged to slide upon a feather in order to connect and disconnect the hand gear, the vertical shafts of which are carried down to a cross shaft underneath the roadway floor.

A 4½-in. shaft extends from coupling L to sprocket Q. This sprocket has 15 teeth. The sprocket chain Z is a special Jeoffrey chain recommended by L. J. Carter, Mechanical Engineer, Chicago, Ill. It is intended to transmit a strain of 7,000 lbs. at a speed of 250 ft. per minute. The small gear O of eight teeth is mounted on a jack shaft with the sprocket wheel Q to which power from the engine is communicated by means of a lighter Jeoffrey chain capable of transmitting 1,600 lbs. at a speed of about 900 ft. per minute. Both link chains R run on a double sprocket wheel S upon the engine shaft. A jaw clutch working on a feather upon shaft, throws the engine in and out of gear. The engine itself is a double oscillating reversible Kriebel engine with 7½ × 9-in. cylinders and speed of 300 to 350 revolutions per minute. With a boiler pressure of 50 lbs. it is capable of opening or closing the bridge in 45 seconds or less.

The bridge so far has not been severely tested by wind pressure, but since the boilers are built to carry 150 lbs. steam pressure, while only 50 lbs. is required to operate the bridge under ordinary conditions, it is believed that ample power is in reserve to operate the bridge during a moderately high wind. On account of requiring less attention, hard coal is burned under the boilers, which are of the submerged tube type, 4 ft. in diameter and 10 ft. high. The engine houses are conveniently ar-

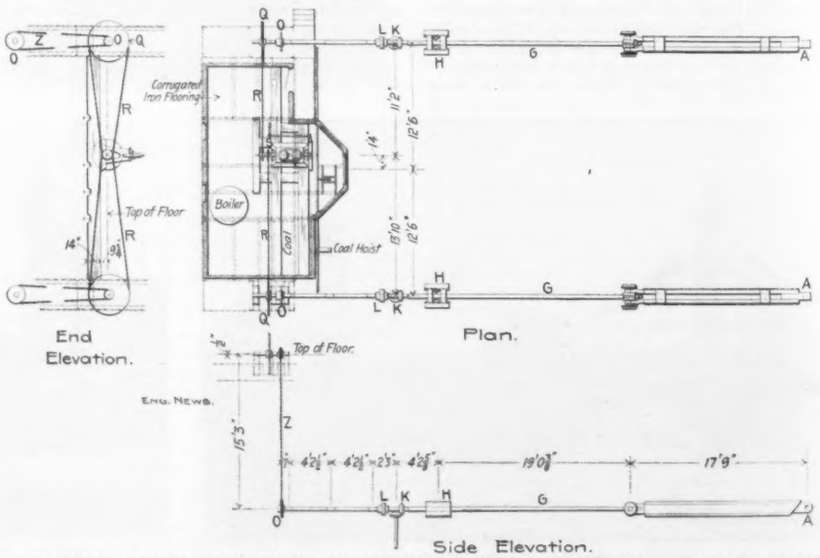


FIG. 4.—DIAGRAM SHOWING ARRANGEMENT OF OPERATING MACHINERY FOR MICHIGAN ST. DRAW BRIDGE.

ranged with coal bin, coal hoist, water supply, electric lights, etc.

Both halves of the bridge are practically of identical construction. It must be opened 40 to 50 times a day for the passage of vessels. The team

and foot travel across the bridge is very heavy. A considerable shear and vibration was expected where the two halves meet at mid-stream on account of the very long swinging trusses; however, under very heavy moving loads it only reached a maximum vertical or horizontal motion of ½-in. A center lock was hardly considered necessary, but finally a small contrivance consisting of a 3-in. square pin at each truss which could be thrown in and out by a hand lever was provided. This device effectually prevents shear and lateral motion and is worked by the bridge tender, who is in control of the structure and who signals the operators in the engine houses at each side when the bridge is to be opened or closed.

So far the bridge has worked in a very satisfactory manner, and it is believed that with ordinary good care it will prove to be a reliable structure. Cooper's specifications governed material and workmanship. The shop inspection was by the Osborne Co., of Cleveland, O., and the field inspection was by the Engineering Department of the city of Buffalo, E. B. Guthrie, M. Am. Soc. C. E., Chief Engineer, and Frank V. Bardol, Assistant Engineer in charge. This bridge was designed in detail by the Engineering Department of the Wisconsin Bridge & Iron Co., of Milwaukee, Wis., and the structural work and machinery was manufactured at its shops and erected by its regular forces. We are indebted to the builders for the information from which this article has been prepared.

THE HOLLAND SUBMARINE BOAT, the "Plunger," was launched, on Aug. 7, at the yards of the Columbia Iron Company, at Baltimore, Md. This is the boat built for the government on special design for the United States Navy. The "Plunger" is 85 ft. long and 11.5 ft. diameter, with a light displacement of 155 tons; and when down to the load line, with superstructure awash, the tonnage is 167 tons. Twin quadruple expansion engines will operate the vessel on the surface; and when submerged a 70-HP. electrical motor will be brought into play. The estimated submerged speed is 6 knots per hour; with 15 to 16 knots at the surface.

ICE BREAKING STEAMERS have been sent to Vladivostok by the Russian government in order to try and keep the harbor open during the winter, as this will be the terminal port of the Siberian Railway, and ordinarily the harbor is closed by ice from November to May. The vessels are similar to the ice breakers employed by the Danish State Railway to keep navigation open for the car transfers or train ferries across the various "sounds" of Denmark.

A REVOLVING DOOR FOR WATER TIGHT BULKheads in ships, invented by Mr. William Kirkaldy, of Glasgow, Scotland, has received the approval of the British Board of Trade and is now being manufactured by the Brandon Bridge Building Co., of Matherwell. The device consists of a hollow cylindrical casing, which is bolted to the water-tight bulkhead, one-half of the cylinder being in one compartment and the other half in the compartment adjoining. In the casing are two doorways, one at the fore part of the cylinder and one at the aft part. Within the casing, and fitting close, is a hollow cylinder, which revolves easily, and has one doorway corresponding in size to the two doorways in the outer cylinder. This inner cylinder is hung from a center bolt at the top and revolves on ball bearings. In operation the opening of the inner cylinder is brought opposite one of the openings in the casing, when the person desiring to pass through the bulkhead steps inside and revolves the inner cylinder until its opening comes opposite the other door of the casing, through which he passes. By this arrangement it will be seen that it is impossible for the passage through the bulkhead to be left open, as one door of the casing has to be closed before the other can be opened.

A NOVEL GANG-PLANK is being employed by the International Steamship Co., at its wharf at Eastport, Me. Owing to a variation of 26 ft. in tide level and the fact that loading is accomplished by trucks, considerable trouble has always in the past been experienced in loading and unloading, and at times several men would be required to push the trucks up the steep gangplank. The present arrangement, as constructed by the Belknap Motor Co., of Portland, Me., is in brief a reversed tread-mill operated by an electric motor through suitable gearing. The gangplank is a framing supporting a moving floor 60 ft. long and 4 ft. wide, upon which the stevedores simply run their loaded trucks and stand until they are carried to the top of the incline. It is found that the conveyor is in every way a success and effects a great saving in time and money.

THE LOSS OF THE STEAMER "MEXICO," southward bound from Alaskan ports to Seattle, Wash., occurred near Sitka, Alaska, Aug. 5. The steamer was running at half speed in a fog when it struck the West Devil reef and went down in deep water in about two hours. The passengers were taken off in the boats and some of their hand baggage was saved, but all the treasure, baggage and freight went down with the ship. The "Mexico" was built at San Francisco in 1882. It was 275 ft. long, 36 ft. beam, with a depth of 20 ft., and a gross tonnage of 1,340 tons. The engines were of 1,500 nominal HP.

A NEW LAKE STEAMER, called the "Starucca," of 5,610 tons displacement and 4,150 tons cargo carrying capacity on 16-ft. draft, was launched at the Union Dry Dock, Buffalo, N. Y., on Aug. 5. The vessel will be operated by the Union Steamboat Line, controlled by the Erie R. R. The dimensions are: Length over all at rail, 346 ft. 10 ins.; beam, 44 ft., and depth 28 ft. The vessel is built of steel throughout, including the decks. The spars, two in number, are also of steel, 100 ft. high, and 24 ins. in diameter at the deck and 6 ins. at the truck. The water bottom is 54 ins. deep and the hold is divided into nine compartments by steel bulkheads. The water ballast is handled by two Deane vertical duplex steam pumps, 8 × 14 × 16 ins., and a single system of piping with a 10-in. main and 6-in. suction in each compartment. The engine, built by the King Iron Works, Buffalo, N. Y., is of the vertical triple expansion type, with three cranks, and cylinders 22, 38½ and 64 ins. diameter by 42-in. stroke. The boilers are four in number, 11 ft. 6 ins. diameter, two of them 13 ft. and two 12 ft. long, built by the Lake Erie Boiler Works, Buffalo, N. Y. They are designed for 175 lbs. steam pressure. The boat is equipped between decks with a double cylinder 10 × 12-in. hoisting engine, with line shafting operating double drums for all the hatches; also with a steam capstan and steam winches, built by the Providence Windlass Co., Providence, R. I., and two Dunn stockless anchors made by the Standard Steel Casting Co., Thurlow, Pa. The steam steering gear is built by Williamson Bros., Philadelphia, Pa. The electric lighting plant consists of two 5¾-K-W. 125-volt Westinghouse dynamos, driven by two Westinghouse "Junior" engines, 6 × 5-in. cylinder. The keel of the boat was laid on Feb. 16, and the machinery is all in place, ready for operation.

THE AMERICAN LINE STEAMER "ST. PAUL" has made the trip from New York to Southampton in 6 days, 13 hours and 37 minutes, starting from New York on Aug. 4. The time is counted between the lightship, off New York, and off Hurst Castle, at Southampton. The "St. Paul's" previous fastest run eastward was 6 d. 14 h. 21 min., in Dec., 1895. The Hamburg-American steamer "Fuerst Bismarck" still holds the record over this route with 6 d. 10 h. 55 min., made in September, 1893. The "St. Paul" has the westward record of 6 d. 0 h. 31 min.

THE FASTEST TRANS-PACIFIC VOYAGE is claimed to have been made by the Royal Mail Steamer "Empress of Japan" on her last trip from Vancouver to Yokohama. The distance is 4,270 knots, and the trip was made in 10 d. 3 h. and 39 min.

ELECTRIC MAGNETS for picking up and handling steel or iron plates are now being used by the Illinois Steel Co. These magnets are double-pole and require only 4 amperes at 240 volts when handling a 5-ton load, although they can be wound for any voltage. They consist of two soft cast-steel poles, of elliptical cross-section, the axes being 3 ins. and 24 ins. These are bolted to a soft steel end or yoke plate 1 in. thick, which serves the double purpose of completing the magnetic circuit and protecting the coils. The poles are placed 7½ ins. apart, and project 10 ins., and are surrounded by the magnetizing coils, which have a section of 7½ × 1½ ins., and are inclosed in a water-tight brass casing. For further protection from mechanical injury, heat or moisture the poles and coils are boxed in with a ½-in. steel casing. A lifting ring and two handles are provided for lifting and convenience in placing. The operation is simple, only requiring some source of current, two flexible conductors or a twin cable and a switch which can be placed either on the crane or at the side of the building in some convenient location. The manufacturers, the Wellman-Seaver Engineering Co., of Cleveland, O., claim that there is no more danger of dropping loads than with the older forms of support, and that the convenience and saving in time due to the fact that the loads are picked up by mere contact more than compensate for the cost of the apparatus.

ELECTRICAL COOKING is being considered quite seriously, and there are many who regard it only a matter of time before electric cooking and heating will be as ordinary as electric lighting now is. As an interesting addition to the information on this subject, Prof. John P. Jackson's paper, entitled "The Economy and Utility of Electrical Cooking Apparatus," read before the recent meeting of the Am. I. E. E., is worthy of attention. To give the matter a fair test, cooking apparatus was obtained and meals prepared for a family of six during a period of several weeks. Measurements of the time required and current consumed were made for each meal. These data were averaged and costs were estimated on the basis of 10 cts. per kilo-watt hour, which may be taken as a fair average of the rates charged by electrical power companies. The results of the test gave a cost per meal of 13.1 cts., or including 3.5 cts. additional for heating water, a total cost per meal of 16.6 cents. Exactly the same dishes cooked in the ordinary way required 12.6 lbs. of coal, which at $5.00 per short ton made an average cost of only 3.15 cts. per meal. It is thus seen cooking by electricity costs about 5.3 times as much as coal cooking. Ironing for five hours, using coal to heat, cost 12.25 cts, while for a shorter period of four hours electricity cost 22.7 cts. As a result, it was clearly shown that while electrical cooking could be done properly and without heat or smell, the cost of electricity due to present expensive methods of production limited its use to chafing dishes, toasters, curling irons, soldering irons and such operations where alcohol or gas are usually employed.

IRON FELT is a new isolating material referred to by U. S. Consul Monaghan, of Chemnitz. It is said to be made of the best woolen material impregnated by a patented, but secret, compound, which it is claimed will withstand a pressure of 2,220 lbs. per sq. centimeter. It is

WEATHER TABLE FOR JULY, 1897. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—rain or melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	69.7	95	44	51	6.3	29	SE	8.04	2.12	15
	Portland, Me.	66.1	88	51	37	6.9	40	SE	2.62	.88	10
	New York City	72.8	89	60	29	10.3	54	NW	9.52	2.56	19
	Pittsburg, Pa.	76.2	99	59	40	5.4	28	S	4.52	1.23	15
	Chicago, Ill.	74.2	95	56	39	13.4	72	W	1.47	.37	9
	Omaha, Neb.	78.8	102	57	45	7.7	43	SW	2.01	1.18	9
	St. Paul, Minn.	73.8	94	55	39	7.4	36	SE	6.35	1.53	13
	Duluth, Minn.	66.4	87	52	35	7.9	48	NW	9.29	4.20	15
	Bismarck, N. Dak.	70.4	99	47	52	8.5	35	SW	1.53	.60	10
	Average.										
Southern Cities.	Washington, D. C.	76.9	92	61	31	5.4	34	N	5.78	1.31	16
	Louisville, Ky.	79.4	100	58	42	6.8	32	N	5.21	1.65	9
	St. Louis, Mo.	80.6	97	62	35	8.3	28	N	3.23	1.41	9
	Savannah, Ga.	82.0	102	67	35	6.4	36	S	8.10	2.00	12
	Kansas City, Mo.	80.4	102	60	42	7.6	24	S	4.29	2.16	7
	Jacksonville, Fla.	82.3	99	68	31	7.1	34	SW	3.67	1.85	13
	Chattanooga, Tenn.	78.6	98	57	41	5.9	32	S	3.43	1.30	13
	New Orleans, La.	83.7	95	71	24	6.6	26	N	4.70	1.60	15
	Memphis, Tenn.	82.1	97	62	35	7.3	35	NW	2.42	.68	6
	Palestine, Tex.	84.4	102	67	35	6.1	36	E	1.01	.80	3
	Average.										
Western Cities.	Helena, Mont.	63.6	95	42	53	8.0	48	SW	1.89	.78	11
	Port Angeles, Wash.	55.1	67	44	23	7.9	34	W	.88	.34	8
	San Francisco, Cal.	58.2	82	47	35	14.3	30	W	T	T	—
	Salt Lake City, Utah.	71.9	94	49	49	6.3	32	S	.69	.59	5
	Santa Fe, N. Mex.	67.0	85	43	42	5.8	33	NE	2.85	.61	14
	Denver, Colo.	69.8	96	43	53	7.6	48	W	2.06	.94	9
	Yuma, Ariz.	91.1	112	60	53	—	35	SE	T	T	—
	Average.										

to be placed between ties and rails to deaden sound and prevent shock. It has been tried on a section of Berlin's elevated railway where 360 trains pass daily, and the result is said to surpass the most sanguine expectations, as the noise is reduced to a minimum and the wear and tear diminished.

A STREET IMPROVEMENT TAX has been levied on bicycles in Chicago, at the rate of $1 per bicycle, whether single or tandem. The money collected will be expended without delay, no council order being required to authorize the expenditure. The license badge is of aluminum, and is clamped to the front fork of the bicycle in such a way that it cannot be removed without being broken. The police are made responsible for all unlicensed wheels within their districts.

THE QUESTION OF CONTROL OVER IRRIGATION water by the State Engineer having been raised by Mr. Willard Young, State Engineer of Utah, State Attorney General Bishop gives the following opinion, as founded on the laws of 1897: To secure uniformity of measurement of water taken from public streams, it is the duty of the State Engineer to issue special instructions as to the proper methods of water measurement to all superintendents of irrigation ditches. But with the issue of the instructions the authority of the Chief Engineer ceases, and he can not compel obedience to them; for, if these instructions are ignored, there are other provisions of the law covering such cases.

THE BULLET-PROOF CLOTH, invented by Casimir Zeglen, and which lately produced so much discussion in Europe, has been tested at Fort Sheridan, Chicago. The test is reported as being made under Col. Robert Hall, of the 4th U. S. Infantry, and with a Krag-Jorgensen rifle. The result is said to have been a triumph for the cloth, which fulfilled all the claims made by the inventor.

BOOK REVIEWS.

MAXIMUM STRESSES IN FRAMED STRUCTURES.—By William Cain, M. Am. Soc. C. E. New York: D. Van Nostrand Co. Boards; 4 × 6 ins.; pp. 182; illustrated.

The present edition of Prof. Cain's familiar little book has been practically rewritten and the scope of its contents considerably changed. As the book is now, it is a short treatise on the calculation of strains in framed bridge trusses of the types commonly used in American bridge practice, both for uniform and concentrated wheel loads. Although a small book the author has succeeded in presenting his subject in a very complete and clear manner.

SURVEYOR'S TABLES.—Being the Tables from the; Manual of Land Surveying. By F. Hodgman, 1897. F. Hodgman, publisher, Climax, Mich. 4¼ × 7 ins.; flexible back; 32 blank cross-section pages; pp. 126. $1.50. The "regular edition," differing only in quality of paper and binding, $1.00.

Commencing with directions for the use of tables, the latter include the following: Logarithms of numbers to 100,000; natural sines and cosines; natural tangents and cotangents; logarithmic sines, cosines, tangents and cotangents; traverse table; natural secants; azimuth of Polaris; multipliers of R.; angles of elevation; mean refraction; acreage of open drains; acreage of tile drains and capacity of tile; azimuths of tangent; offsets from tangent; minutes in decimals of a degree and inches in decimals of a foot; radii and deflections; tangents and externals to 1° curve. An appendix gives useful extracts from the U. S. Surveying Instructions, 1894.

THE OFFICIAL RAILWAY LIST.—A Complete Directory of the Presidents, Vice-Presidents, General Managers and Assistants, General and Division Superintendents, Chief and Assistant Engineers, Secretaries, Treasurers, Auditors, Traffic Managers, General Freight Agents, General Passenger and Ticket Agents, Baggage Agents, Superintendent of Telegraphs, Purchasing Agents, Fuel Agents, Car Accountants, Superintendents of Motive Power, Master Mechanics, Master Car Builders, Master Car Painters, Foreman of Repairs, Roadmasters, etc., of railways in North America. A handbook of useful information for railway men. Sixteenth year. Charles A. Blake, Editor; Edwin N. Lewis, Manager. Chicago Railway List Co. Cloth, oblong; 3½ × 8 ins.; pp. 412. Cloth, $2.00; flexible leather, $3.00.

With so full a title, little further need be added as to the purpose of this useful publication, other than to say that it carries out its promise in a manner creditable to its editor. The "useful information" referred to relates to standards in car and track equipment, illustrated, and to handy tables and good advice intended for railway men.

HYDRAULIC MACHINERY: With an Introduction to Hydraulics.—By Robert Gordon Blaine, M. E., Assoc. M. Inst. C. E., Senior Demonstrator and Lecturer in the Mechanical Engineering Department of the City and Guilds of London Institute's Technical College, Finsbury. London: E. & F. N. Spon. New York: Spon & Chamberlain. Cloth; 5½ × 8¾ ins.; illustrated; pp. 383; $5.00.

This work is intended for class use as one of the Finsbury Technical Manuals; but it is of value to all engineers as bringing the subject of hydraulic machinery up to date. The introduction to hydraulics is put in a very practical form, with illustrations drawn from familiar machines, such as the Greathead tunneling shield, the jet-pump, water meters, etc. The various chapters take up the hydraulic press, jet propulsion, nozzles and jets, water wheels, centrifugal pumps, turbines, speed regulators, hydraulic transmission of power, hydraulic cranes, canal lifts, engines, bridge and dock machinery, machine tools, brakes, rams, etc. Under each of these heads many theoretical and practical data are given, with full illustrations of late application of hydraulic power. The whole subject is very well handled, and Mr. Blaine is to be congratulated upon producing a new book upon an old subject that is both interesting and valuable as a text-book and book of reference.

ELEMENTS OF THE DIFFERENTIAL AND INTEGRAL CALCULUS, WITH APPLICATIONS.—By William S. Hall, E. M., C. E., M. S., Professor of Technical Mathematics in Lafayette College. New York: D. Van Nostrand Co. Cloth; 8vo.; pp. 249. $2.25.

The preface to the book states that it is intended for colleges and technical schools. The object has been to present the calculus and some of its important applications simply and concisely, and yet to give as much as it is necessary to know in order to enter upon the study of those subjects which presume a knowledge of the calculus. The book will be found to be adapted to the needs of the mathematical student, and will also enable the engineer to get that knowledge of the calculus which is required by him in order to make practical application of the subject. All of the formulas for differentiation are derived by the method of limits, but the differential notation is fully explained and is employed when there is any advantage gained by so doing. Practical applications of the calculus are given at some length, and numerous problems from mechanics and different branches of applied mathematics are given. A chapter on differential equations is included and a table of integrals is appended. The book is handsomely printed and we have no doubt it will prove to be an excellent text book for technical schools.

THE MINERAL INDUSTRY: Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1896. Vol. V. Edited by Richard P. Rothwell, Editor "Engineering and Mining Journal." Scientific Publishing Co., New York and London. Cloth; 8vo.; pp. 865; $5.

The present volume of "Mineral Industry" is a worthy companion of the four annual volumes which have preceded it. It is an exhaustive compilation of the mineral statistics of the world, with elaborate reviews of the trade conditions existing throughout the year 1896 in every branch of the mineral industry, together with a series of technical articles by many of the leading mining engineers and metallurgists, both of this country and Europe. The following is a list of the principal technical articles: "Metallurgy of Tin," by Prof. Henry Louis; "Cement Manufactured in Great Britain," by W. H. Stanger and Bertram Blount; "Progress in Electro-Chemistry and Electro-Metallurgy in 1896," by W. Borchers; "Missouri Clay," by Charles Rollin Keyes; "Present Practice in Coal Washing in Germany and England," by Richard Cremer; "Modern Coke-Ovens and their By-Products," by George Lunge; "The Barrel Chlorination Process," by John E. Rothwell; "Chloridizing Roasting of Calcareous Silver Ore," by Otokar Hofmann; "Hydro-Metallurgy of the Precious Metals," by Henry Wurtz; "Manufacture of Basic Iron in Alabama," by W. B. Phillips; "Recent Improvements in Lead Metallurgy," by H. O. Hofman; "The Petroleum Fields of Wyoming," by Wilbur C. Knight; "Phosphate Mining in Tennessee," by Lucius P. Brown; "The Rare Elements," by L. M. Dennis; "Zinc and Cadmium," by W. R. Ingalls; "Zinc Refining," by Bruno Kerl; "Mine Labor as Regulated by Law in the United States," by W. F. Willoughby; "The Diffusion of Metals," by W. C. Roberts-Austen; "The Micrographic Analysis of Metals," by J. O. Arnold; "Progress in Ore Dressing," by R. H. Richards; "Electricity in Mining," by Timothy W. Sprague. The book has a most complete index, containing over 5,000 titles, and is well printed and bound.

STRUCTURAL MECHANICS.—The Action of Materials under Stress, or Structural Machanics, Comprsing the Strength and Resistance of Materials and Elements of Structural Design, with Examples and Problems.—By Charles E. Greene, A. M., C. E., Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. Published by the Author. 8vo.; cloth; pp. 271. $3.00.

The title of this work, we think, would more correctly express its scope if the words "Structural Mechanics" were omitted. The book is a treatise on the strength of materials, which is only one portion of the broader subject of structural mechanics. The work is essentially a text book for use in engineering schools. The author has condensed the mathematical portion of his subject into smaller space than is commonly done in such works, and gives more space to practical observations concerning engineering practice. As far as we have examined the book, the author's general method of treatment appears to be excellent, and the work should be found useful not only in the class room but also as a reference book in an engineer's library. We notice a few minor defects which may be remedied in future editions. Thus on p. 7, the modulus of shearing elasticity is stated to be the ratio of the displacement to the unit shear. If a ratio of two quantities is the quotient of the first-named quantity divided by the second, then the modulus would be a fraction, which we do not think the author intends. On p. 24 the manufacture of wrought iron is thus described.

Commonly white iron is melted in a cupola furnace and then run into a Bessemer converter or a reverberatory furnace for treatment.

The author should submit this paragraph to an intelligent metallurgist for revision. On p. 27 the tensile strength of cast-iron is "roughly represented" by 25,000 lbs. per sq. in. This figure is scarcely ever reached in common foundry cast-iron unless especial care is taken in making the mixture. On p. 29 it is stated that cast-iron for water pipes is usually required to have from 16,000 to 18,000 lbs. per sq. in. tensile strength. These figures are better than 25,000 for a rough statement of the strength of cast-iron. On p. 28 is given a classification of steel by La Societe Cockerill. It gives extra soft steel as from 0.05 to 0.20 carbon and from 57,000 to 70,000 lbs. tensile strength. This ancient and worthless classification from Belgium should be replaced by a modern American one.

On p. 212 the author gives rules from Unwin which make the diameter of a rivet twice the thickness of the plate. This is an absurd rule, as the author will admit, for plates 1 in. in thickness and upwards, which are now commonly used in marine boilers. We find in an old edition of Unwin's Machine Design, the rule "diameter = 1.2 × square root of thickness, a much better rule than the one credited to Unwin by Prof. Greene.

On p. 220 Fairbairn's old rule for collapsing strength of tubes is given, without a word to call attention to its hoary antiquity, to the limited number and range of the experiments upon which it is based, and to the desirability of new experiments on tubes made from modern materials.

ELECTRIC RAILWAYS AND TRAMWAYS; THEIR CONSTRUCTION AND OPERATION.—A Practical Handbook Setting Forth at Length the Modern Application of Electricity as a Motive Power for Railways and Tramways; Containing Complete Financial and Engineering Data as to Design, Construction, Equipment and Working; Fully Illustrating all Modern and Accepted Types of Machinery and Apparatus, and Describing in Detail the Principal Installations in Europe and America. By Philip Dawson, M. Inst. Elec. Engrs., M. Inst. C. E., etc. Reprinted with additions from "Engineering." London: "Engineering;" New York: John Wiley & Sons. Half morocco; 9½ × 11 ins.; pp. 677; 503 illustrations; 183 tables; $12.50.

The chief fault which we have to find with this volume is the needlessly expensive and cumbersome form in which it is published. By the use of large type and wide spacing, broad margins, thick paper, gilding, and morocco binding the book is fully twice the size and price it need to be to satisfy all the conditions of good publishers' work. The great shame of this lavishness is that a good book is placed beyond the means of a large number of young engineers who would most benefit by it, while its convenience as a manual for daily use is injured for those who can afford, without great hardship, to spend several dollars extra for mere embellishment.

The basis for the book was a series of articles published in "Engineering," of London, which have been considerably modified and supplemented by new matter to fit them for book form. An idea of their scope and character as they are now presented is best given by quoting the headings of the various chapters, which are as follows: (1) Introductory and General; (2) Permanent Way; (3 and 4) The Return Circuit; (5) Elevated Conductor Construction; (6 and 7) Erection of the Trolley Wire; (8) Motors; (9) Speed Regulators; (10) Car Wiring and Equipment; (11) Motor Trucks; (12) Car Construction; (13) Car Wheels and Brakes; (14) The Trolley; (15) The Power House; (16) Generators; (17) Switchboards; (18) Central Stations; (19) West End Street Ry. Co. of Boston; (20) Chicago City Ry.; (21) City and Suburban Ry. Co., Baltimore; Cass Ave. and Fair Grounds Electric Ry. Co., St. Louis, and other Typical Power Plants; (22) Long Distance Power Transmission, Portland and Oregon City; (23) Electric Railway Locomotives; (24) Nantasket Beach Ry., and Metropolitan Elevated Ry., Chicago; (25) British Electric Railways; (26) Combined Light and Power Plant; (27) Open Conduit Systems; (28) Surface Contact Systems; (29) Storage Batteries as Applied to Traction Purposes; (30) Specifications; (31) Accounts and Their Classification; (32) Management of Electric Lines; (33) Organization, Discipline and Rules; (34) Efficiency, Maintenance and Depreciation; (35) Statistics and Working Expenses. Appendix: Laws, statutory rules and orders respecting electric traction in Great Britain.

The aim of the author everywhere seems to have been to present the latest practice and experience, both in America and in Europe, that relate to his subject, and to content himself with pointing out the salient features of what has been done in developing electrici y as a tractive power, rather than with discussing its theory, possibilities and future improvements. Generally he has done his work well; the descriptions are clear, and the illustrations, with but few exceptions, are pertinent and well executed. An adequate index and lists of tables and illustrations make the consultation of the text easy. If it were not for the fault already mentioned, we should unreservedly recommend the purchase of the book by any one interested in the subject of electric traction.